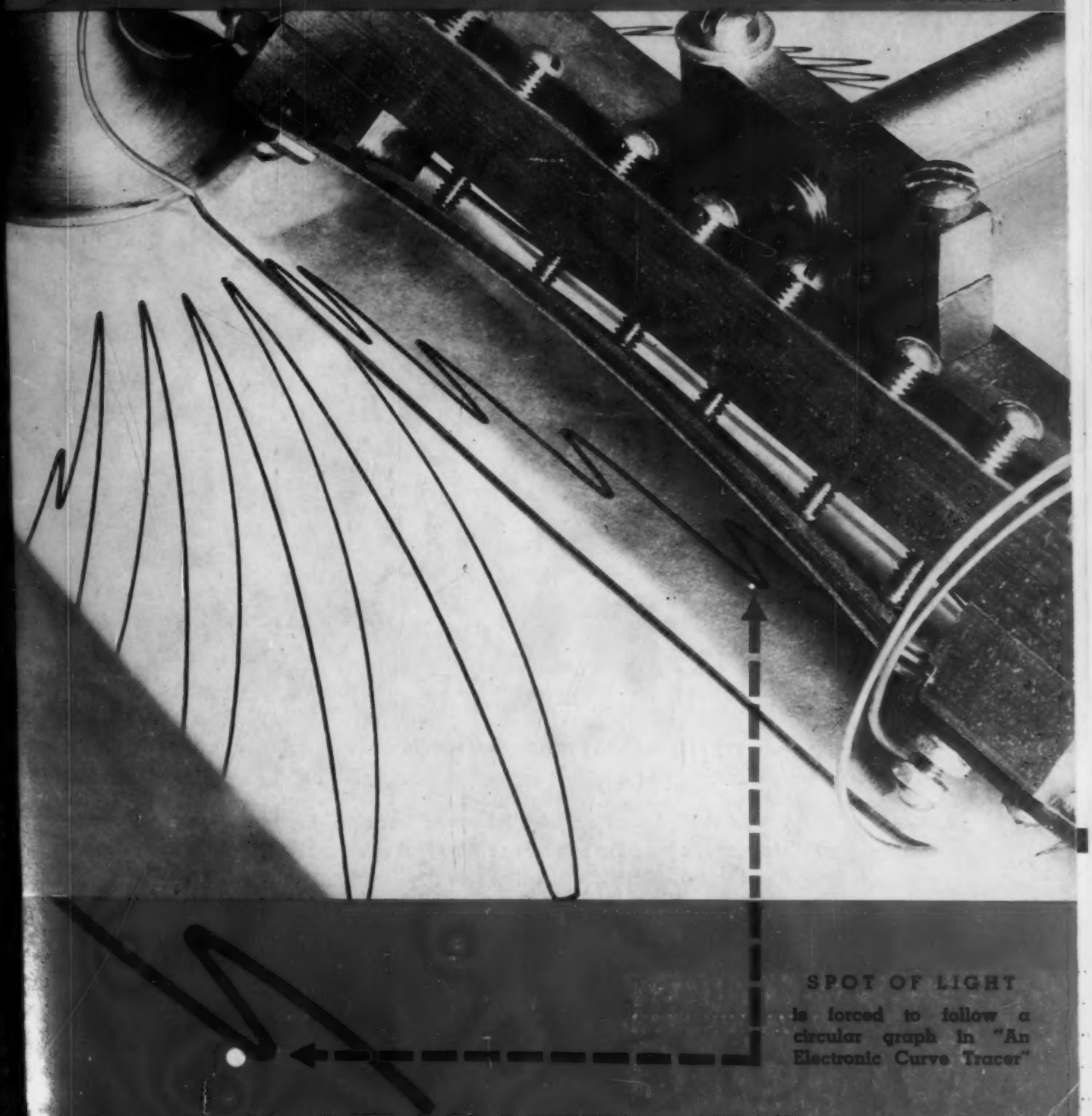
FEBRUARY · 1943

electronics



SPOT OF LIGHT

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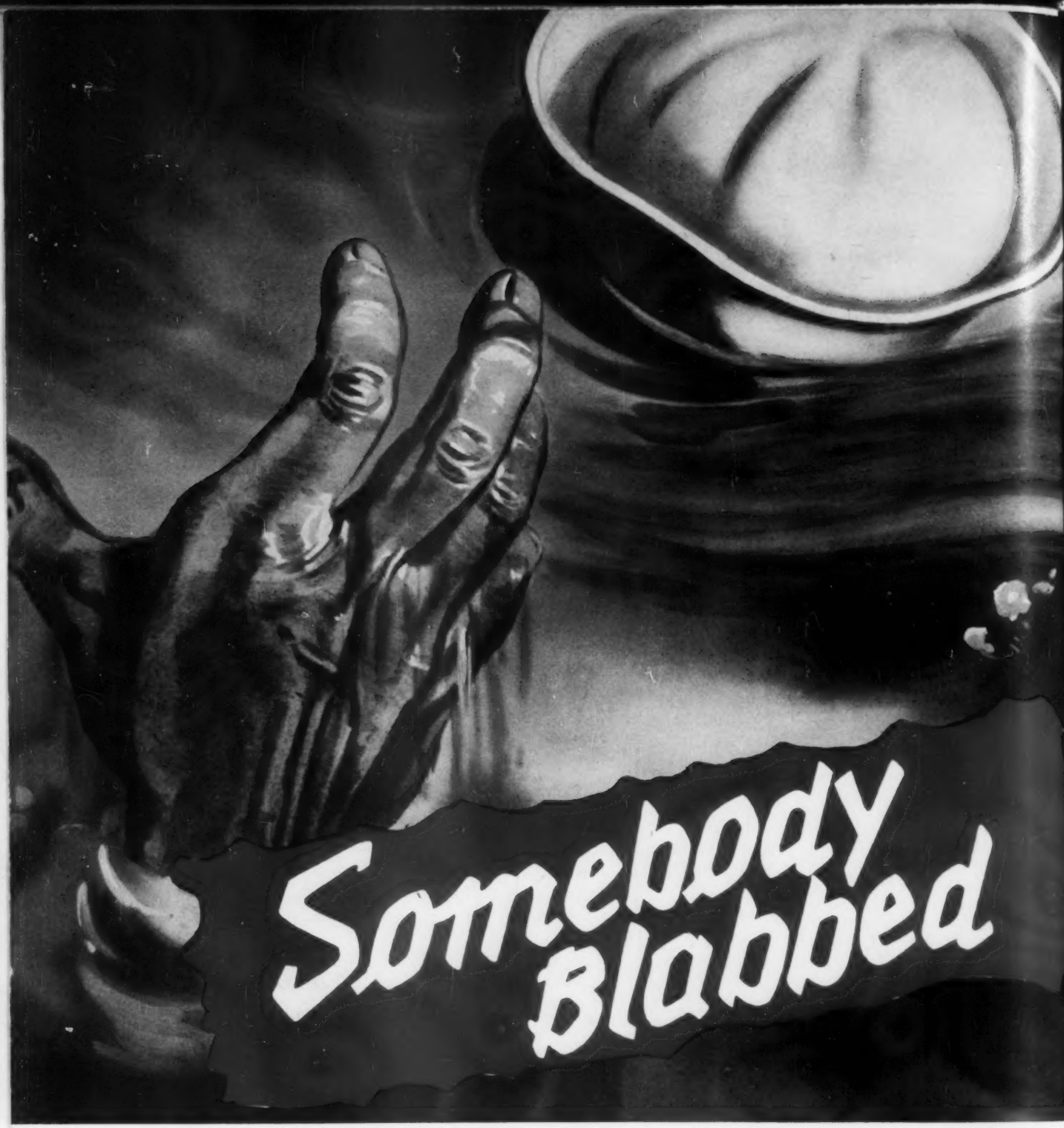

A heavy responsibility rests on all men in war industries . . . especially upon executives and engineers.

Their knowledge of confidential operations should not be the subject of discussions beyond the confines of the plant . . . nor should their natural pride in accomplishments cause them to speak unthinkingly. Discretion is an essential part of war production.

AMPEREX ELECTRONIC PRODUCTS
79 WASHINGTON STREET BROOKLYN, NEW YORK

electronics

FEBRUARY • 1943

THE WAR AND RADIO STANDARDS, by Harold P. Westman 56
Outline of procedure for establishing standards on radio components. Increased efficiency, production and interchangeability result from standardization

AN AUTOMATIC PRODUCTION TESTER, by D. A. Griffin and N. B. Smalley 58
Motor operated rotary switch in conjunction with a-c and d-c bridge compares electronic equipment coming off assembly line with standard, handling 120 circuits in 4 minutes

VARIABLE WAVEFORM UNIT FOR TESTING ALUMINUM, by H. Klemperer and J. W. Dawson 62
Electronically controlled resistance welding supply unit for the purpose of investigating the effects of welding current waveform in aluminum alloy resistance welding

500 Watt CW TRANSMITTER 67
Description of several electrical and mechanical features which facilitate operation and maintenance of 1,500 to 30,000 kc equipment by relatively inexperienced personnel

ADJUSTING SENSITIVE RELAYS, by R. T. Fisher 70
Practical suggestions on the proper adjustment of sensitive relays so that they operate with the proper pull-in and drop-out currents

THE FUX NAVIGATOR, by D. D. Jones 74
The inductive field of a three-phase power line feeding WABC's transmitter on Columbia Island is used during foggy weather to guide the vessel transporting operating personnel

SIMPLIFIED ELECTRON MICROSCOPY, by C. H. Bachman 78
Development of the electron microscope leading to the introduction of the General Electric instrument with horizontal electron path; electrostatic lenses; simplified operation

TEST GENERATORS AND CHAMBERS, by W. W. MacDonald 82
Description of commercially available machines designed to help manufacturers meet rigid specifications

AN ELECTRONIC CURVE TRACER, by Philip Padva 87
How a spot of light may be forced to follow a curved graph by means of a phototube, amplifiers and accessory apparatus

DESIGN CHART FOR SOLENOID INDUCTANCES, by T. C. Blow 91
Nomogram permits determination of inductance of single-layer coils by drawing two straight lines

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DEPARTMENTS

Washington Feedback 53
Crosstalk 55
Reference Sheet 91
Tubes at Work 98
Book Reviews 118, 208
Electron Art 126
News of the Industry 152
New Products 180
Index to Advertisers 209

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To .....

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Waste *is as damnable as sabotage*

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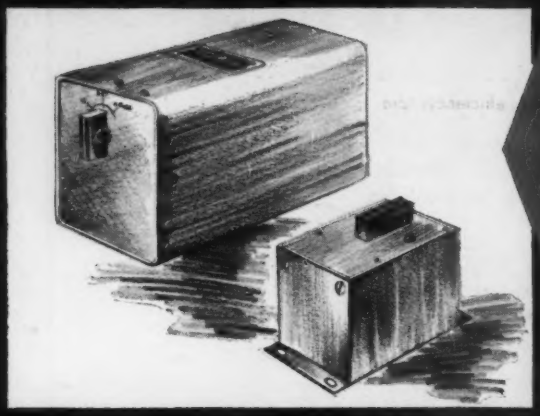

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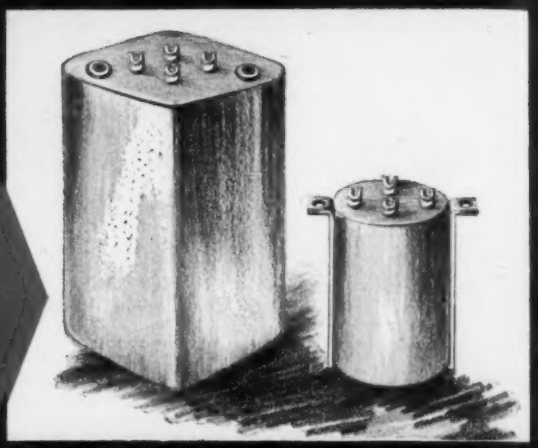

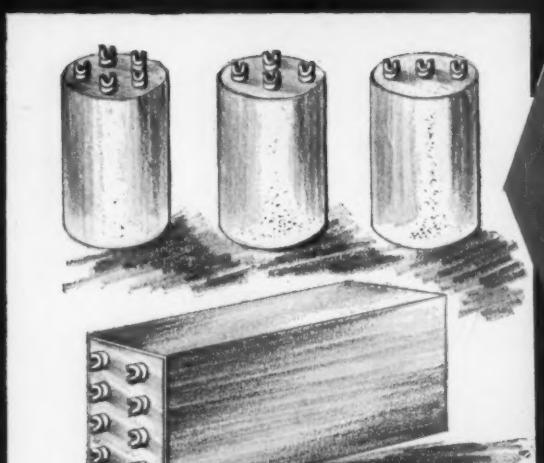

This application employed three of our Ouncer units. By combining the three in one case, we eliminated two aluminum housings, four terminals, two terminal strips, etc.

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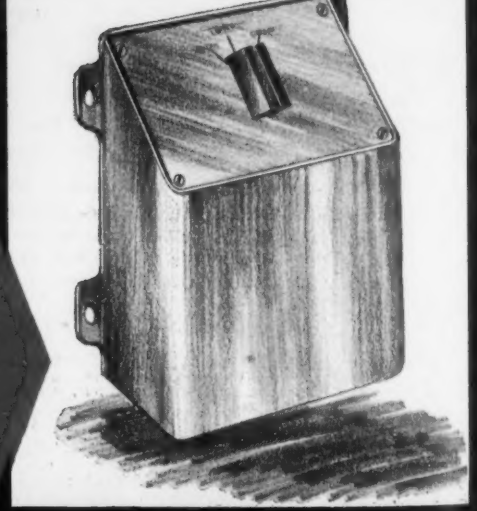

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CROSS TALK

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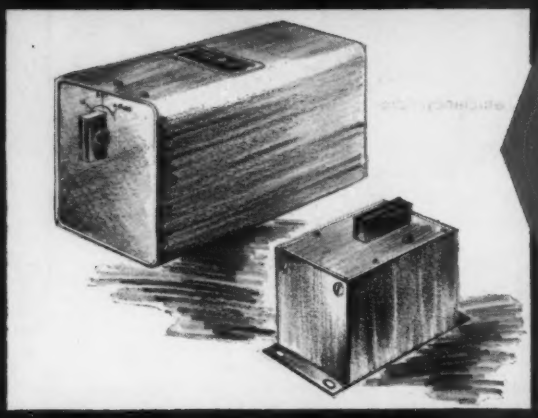

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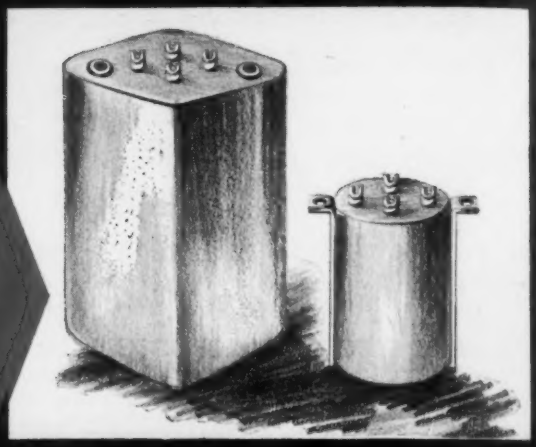

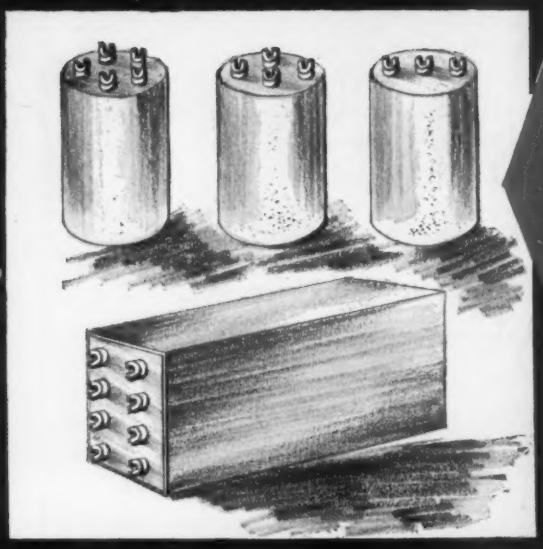

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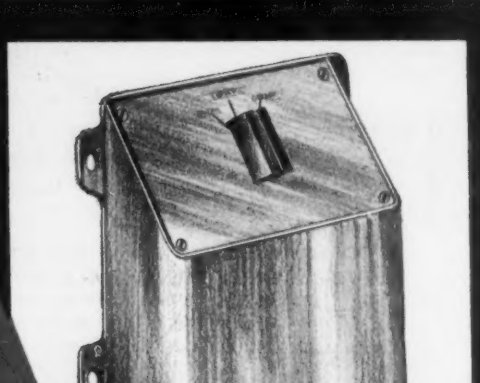

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The WAR and Radio Standards

By **HAROLD P. WESTMAN**, *Secretary, War Committee on Radio, American Standards Association*

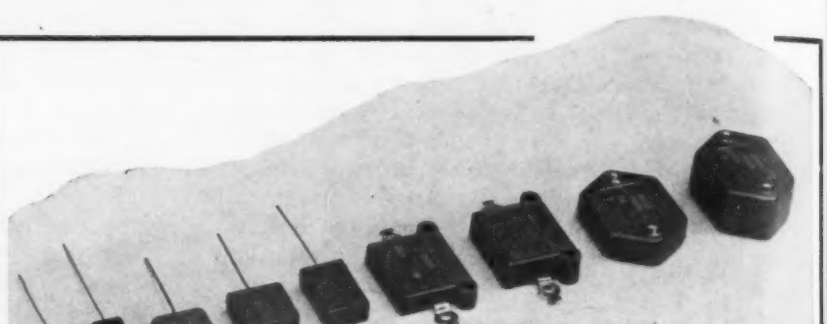
Standardization of radio components, reduces variety of sizes and shapes, assures complete interchangeability of equivalent units and establishes methods of test and inspection which enables inexperienced personnel to carry out, effectively, inspection operations

WAR brings with it a prime necessity to reduce waste of both man hours and materials. While these may be translated into dollars and cents in peacetime and balanced against each other, wartime makes such a simple process inadequate for supplies of labor and materials are not unlimited and may vary in their availability from time to time.

The outstanding effectiveness of simplification and standardization in reducing waste was one of the first observations of those responsible for the production of radio equipment for use by our Armed Forces. Thus, very soon after our precipitation into the war, a proposal was made by the War Production Board to the American Standards Association for an investigation of the possibilities of standardization of radio components beyond that accomplished during peacetime. A conference attended by representatives of the War Production Board, American Standards Association, Sectional Committee on Radio[1], Institute of Radio Engineers, Radio Manufacturers Association, and a group of the larger prime contractors of radio equipment examined the possibilities and set up the War Committee on Radio. Representatives of the Armed Forces were not present at this conference as it was thought best to approach the Services with a specific program.

Several components, which were thought to be susceptible to increased production if suitable standards were prepared, were listed and fixed mica-dielectric capacitors were chosen as the "guinea pig". The program was considered too indefinite for formal committee procedure and the problem was assigned directly to the secretary.

A series of weekly meetings with the prime contractors and then the mica-capacitor manufacturers ensued and some tentative standards were prepared. Later, a more definite program was laid out by the War Committee on Radio and the participation of the representatives of the Armed Forces resulted. This was exceedingly important as it permitted all three interested groups to join in the work and reduced the frequency and extent of revisions.



The standard range of capacitors for receivers and low-power transmitters is illustrated above. The smallest unit is available in capacitances between 5 and 510 micro-microfarads with 500-volt rating. Courtesy Cornell-Dublier Electric Corp.

The following list of components are on the agenda of the War Committee on Radio:

1. Insulating Materials
   - (a) Steatite
   - (b) Plastics
   - (c) Others
2. Insulating Forms
   - (a) Steatite
   - (b) Plastics
   - (c) Others
3. Capacitors—Fixed
   - (a) Mica
   - (b) Paper
   - (c) Electrolytic
   - (d) Ceramic
4. Capacitors—Variable
   - (a) Receiver
   - (b) Transmitter
   - (c) Trimmer

[1] The peacetime ASA committee on radio standardization.

These standard capacitors cover the transmitting range. The largest is 10 inches tall, weighs 24 pounds, and is manufactured in ranges from 100 micromicrofarads at 35,000 volts to 10,000 micromicrofarads at 15,000 volts. Courtesy R. C. A. Mfg. Co.

5. Dynamotors and Similar Power Units
6. Crystals and Holders
7. Resistors—Fixed
   (a) Composition
   (b) Wire Wound
8. Resistors—Variable
   (a) Composition
   (b) Wire Wound
9. Transformers
   (a) Power
   (b) Audio Frequency
   (c) Radio Frequency
10. Tube Sockets
    (a) Receiving
    (b) Transmitting
    (c) Cathode-ray
11. Connectors
    (a) Telephone Jacks and Plugs
    (b) Multicontact Plugs and Receptacles
12. Dry Batteries
    (a) Single Cell
    (b) Multicell
13. Vibrator Power Supplies

Committee work is already in progress on insulating materials and forms, fixed capacitors of mica, paper, and ceramic dielectric, dynamotors, crystals and holders, fixed and variable composition and wire-wound resistors, and vibrators. Work on the remaining subjects will be started as the present demands on personnel permit. The active program now represents a very large proportion of the total number of components which go into radio equipment.

The standards are prepared in the form of a Federal Specification so they may be used directly in the procurement of components, both separately and in assemblies. To as great an extent as possible, they are based on the performance of each component as measured by test and not on its constructional or material design. Thus, failure of existing supplies or new developments in materials or processes need not require revision of the specification at a later date unless they result in an improved product which will withstand more stringent operating conditions.

Each specification gives the physical dimensions of a limited number of sizes of the component covered and the electrical characteristics or dimensions that will be standard in each size. Approval of a component is based on its passing a series of tests designed to prove its ability to stand up in service.

To insure most economical manufacture, the testing is not limited to acceptance of units by the purchasing agency. Tests to disclose variations in the production processes and materials are included to aid in maintaining maximum production of useful components.

Differences of opinion between production and inspection personnel as to the meaning of a specification, particularly where the result of a test is left to the judgment of an inspector, are not unknown and may result in substantial delay in production. Consequently, every effort is being made to avoid any possibility of ambiguity or confusion.

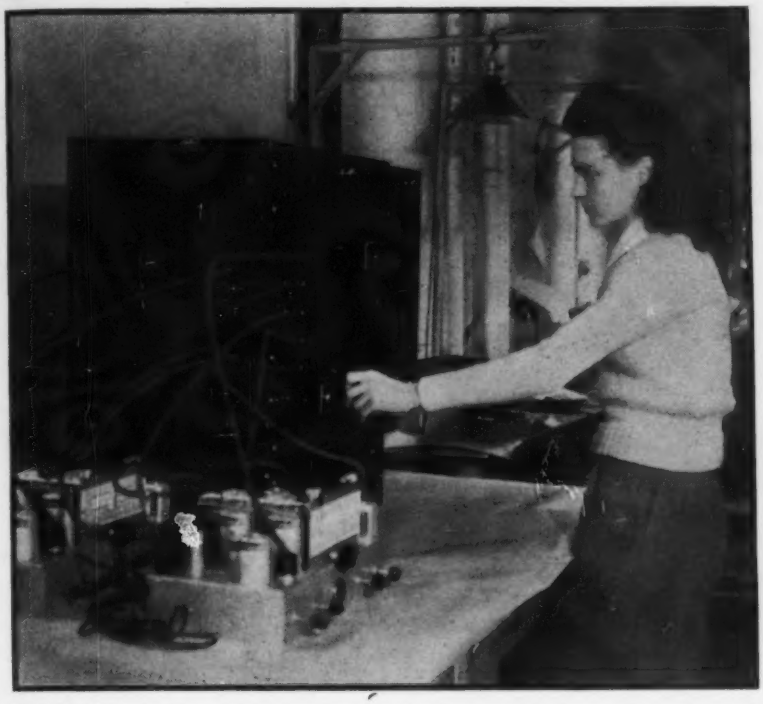
A further problem concerns the necessity for delegating testing to girls who have only high-school educations and a month or two of training as inspectors. This makes mandatory, the presentation of all material in clear, simple language. Engineering data are necessarily reduced to tables or simple graphs. The necessity for slide-rule computations or other interpretations is likely to cause trouble and delay.

The standard on fixed mica-dielectric capacitors has been approved as an American War Standard already. It not only provides completely unified performance specifications but all other requirements are also made identical regardless of which branch of the Armed Forces will use the capacitor.

In the past the various services have set up their own individual systems of identifying each radio component. The new standard provides a common designation which will permit complete interchangeability.

Where combat areas are scattered all over the world, the ability to provide replacements for parts which may be damaged or fail in service is particularly important. Every unneeded spare part is a gift

(Continued on page 179)



"Rotobridge" in use, comparing circuits of r-f tuner with those of chassis used as a standard. Operator writes down identifying number of any circuit on which indicator stops, denoting trouble, presses re-set button to resume checking and winds up with list of numbers representing defective circuits

By DANA A. GRIFFIN

and

NEWTON B. SMALLEY

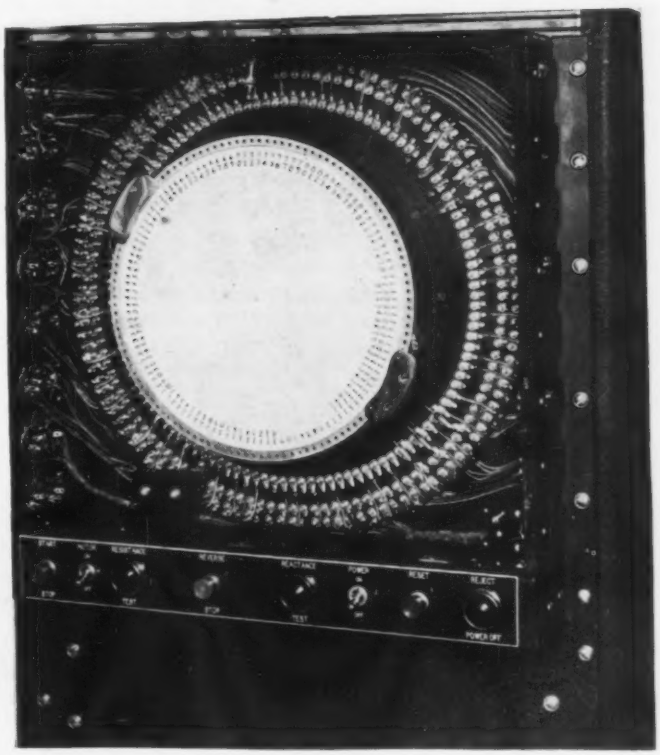
Communication Measurements Laboratory

Front view of unit, showing window through which dial identifying each circuit under test is viewed, controls and one of two groups of connectors

There is a need for a high-speed method of checking electronic equipment in sub-assembly and/or complete form for the following things; open circuits, short circuits, wiring errors and incorrect values of resistance, capacitance and inductance. While the pre-testing of components is supposed to eliminate the last three items, every production man is familiar with errors which occur because of mistakes in color coding or the misinterpretation of such coding. If the majority of these troubles can be located automatically the number of defective units that reach the dynamic test position will drop sharply. If, furthermore, unskilled operators can identify circuits in which there is trouble and pass this data along to skilled trouble-shooters additional time will be saved.

Tester Operating Principle

One approach to the problem is the use of an automatically operated Wheatstone bridge with which the circuits of electronic equipment coming off the assembly line may be compared with the circuits of a standard chassis. Stated briefly, a standard set known to be correctly wired and having component parts



Front view of upper part of unit with protective panel removed. To set up the machine an engineer plugs in a standard electronic unit whose circuit resistance, capacitance and inductance values are near the middle of the permissible tolerance range, clips resistors across contact points to obtain suitable bridge circuit sensitivity and affixes stops on the periphery of the indicating dial to automatically control the machine

An AUTOMATIC PRODUCTION TESTER

Motor-operated rotary switch permits unskilled operator to check 120 circuits in 4 minutes. A-c and d-c bridge makes static comparison between electronic equipment coming off assembly line and standard. Pointer travelling over numbered dial indicates location of wiring errors. Machine rejects incorrect resistance, capacitance and inductance values

EXCEPT in publications devoted to pure research, the reader of any current technical magazine is almost certain to encounter the word "production" in the opening paragraph. The reason for this is obvious. A year ago the accent was on the development of electronic equipment and the conversion of factories to the war effort. Now, with a majority of designs frozen and factories tooled for action, attention is concentrated upon production problems.

The enormous volume of equipment required and the need for greater precision in manufacture imposes serious burdens on the industry. To these difficulties must be added another of equal importance, the loss of skilled personnel to the armed services. Production in itself is easy to achieve. But, as many manufacturers have found to their sorrow, production that passes government tests is another matter.

The purpose of this article is to describe one approach to the problem of making high speed static tests on all types of electronic equipment without the use of highly trained personnel. This, in turn, makes it possible to utilize the available supply of skilled testers and trouble-shooters to best advantage on dynamic tests which are also necessary in the production of most apparatus.

Factory Test Requirements

It has become the almost universal practice of manufacturers to pre-test all component parts going into their product. The next step in the testing procedure is usually the static testing of sub-assemblies. The final check of finished equipment may be divided into two parts, a static followed by a dynamic test. It is apparent that if means are provided to make static sub-assembly and final tests automatically with unskilled personnel an increase in efficiency will be obtained.

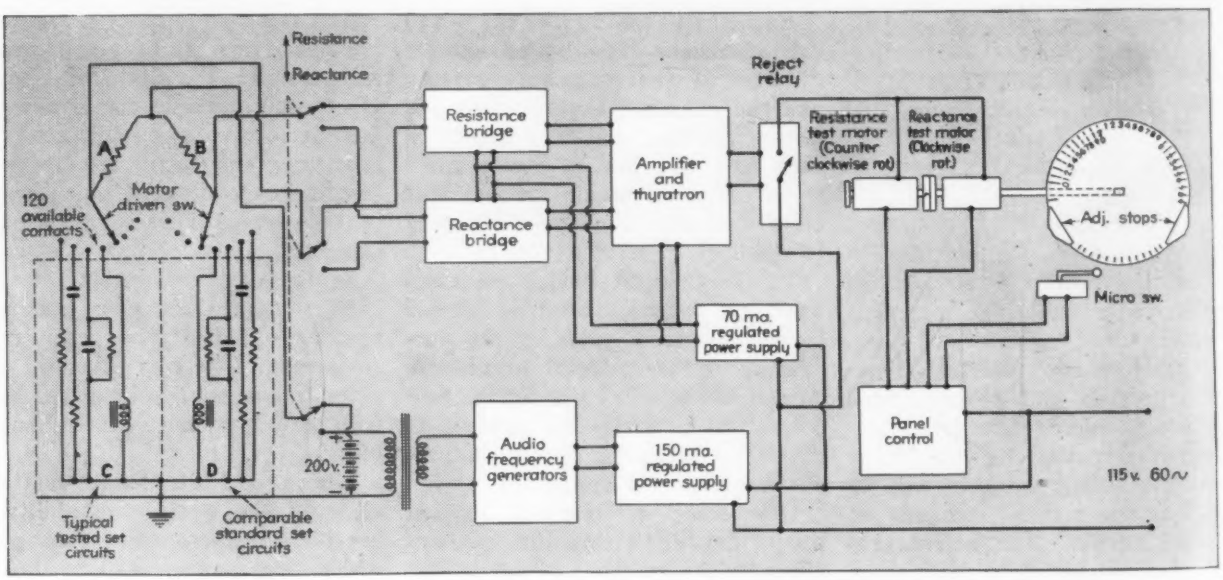


Fig. 1—Block diagram showing component parts of automatic production tester. Resistors, capacitors and inductances within dashed lines at left represent typical circuits to be compared, one group being in a standard unit and the other in a similar production unit under test. The standard unit and units to be tested are connected to the machine by means of plug-in cables

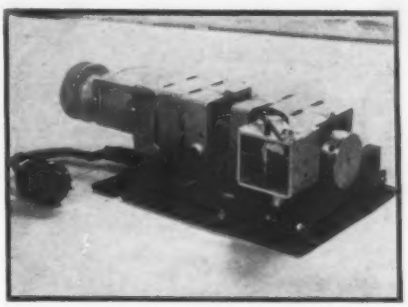
circuit considerations, provides power for the bridge amplifier and thyratron circuits. The main power switch is located on the panel of this unit, together with an indicating pilot light. Three screwdriver adjustments, protected by covers, are located on the front panel for the adjustment of the amplitudes of the three audio frequencies that are used in the system. The voltage output of the two power supplies is controlled by two similar potentiometers located at the rear of the chassis. Line voltage may vary from 95 to 130 volts without affecting the operation of the unit.

The upper chassis contains the bridge itself, the motor drive equipment, amplifier and thyratron circuits. Control switches and the indicating lamps required to operate the unit are located along the front edge of this chassis. Design is such that all major parts can quickly be replaced in the event of breakdown. The dual motor drive unit slides on rails so that driving belt tension may be easily adjusted. All motor and brake connections are made to the chassis by means of a plug and socket. The bridge components are also easily replaced. This assembly is housed in the shield can on which the rotary switch slipring contact assembly is located and is isolated above ground on Bakelite strips which are held in place by four screws. The moving contact assemblies on the rotary switch arm are subject to some wear. They can be quickly removed by loosening a setscrew in the arm and removing the connecting wire from the slip-ring.

The rotary switch arm which makes contact with the circuit elements in the standard and test sets is driven at ½ rpm. Two contacts on the arm make contact with two concentric sets of contact points mounted on a Bakelite sub-panel. There are 120 contacts in each set and these are connected to a series of octal sockets on the sides of the unit. Connection to the circuit elements in the two sets is then made by means of cables fitted with plugs on each end. This makes it possible to connect the two fixed arms of the bridge to the same circuit element in both sets at the same time. Connection from the two moving contactors is made by means of slip-rings and wiping contacts that connect to the fixed bridge elements.

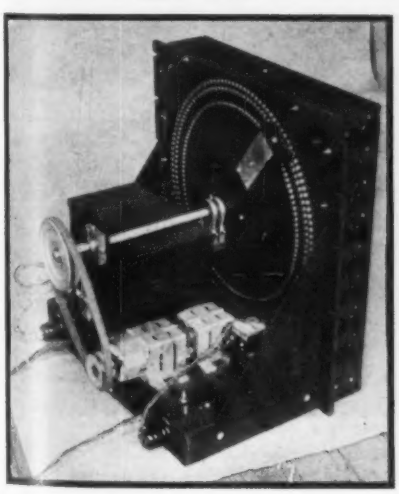
A socket is brought out to the rear apron of the chassis with the critical voltages connected thereto, so the voltages applied to the various component parts of the tester can be readily observed. A jack for an oscilloscope is also supplied. This is connected at the output of the audio amplifier so that its condition and the balance of the two bridges may be checked. Connection to the power unit is made by means of two plug and socket combinations.

The multitude of contacts employed must be carefully aligned and the center of the drive-shaft accurately located. A ½ inch steel shaft is used, with two hand-fitted bronze bearings. These bearings are mounted in steel blocks. Their position on the back shaft support and the front panel can be adjusted to true center should such adjustment prove necessary. A safety microswitch is included in the unit so that when the front cover is opened all shock hazard is removed. Another microswitch is used to control circuit selection functions to be described later. A toggle switch is provided to turn off the motor drive so an engineer can rotate the arm by hand when setting up the equipment. Each circuit element can then be examined at leisure.

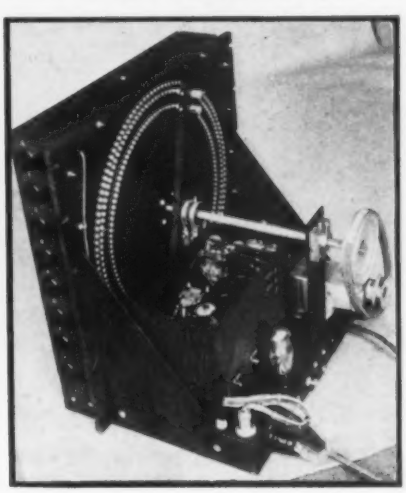


Motors and magnetic brake are mounted on a removable steel plate. Action by the reject relay removes power from both motors and energizes the brake solenoid, eliminating the possibility of the indexing disc coasting and thus indicating an erroneous circuit number

Inside view of upper chassis. The end of the rotary switch arm carrying a shorting shoe for the arming circuit is visible. The motor assembly slides on rails for adjustment of belt tension. Bridge components and amplifier are housed in the metal shield can



Another inside view of the upper chassis. Here the two circuit selecting bridge contactors are shown. Semi-permanent bridge adjustments are made with a screwdriver through holes in the back of the shield can. The thyratron tube is in the lower chassis, not illustrated here



Operation Procedure

To operate the unit, connections are made to the standard set and to the set under test. Then the starting button is pressed. This connects the resistance bridge shown in Fig. 2 to the fixed arms and starts one of the driving motors. The arm revolves at a rate of one circuit per second. At the same time, a green pilot light labeled "Resistance" lights on the control panel. As the switch arm revolves, all resistance paths back to ground are compared one after another. The starting button actuates a stepper type relay and it is possible by depressing it a second time to cut off the motor and stop

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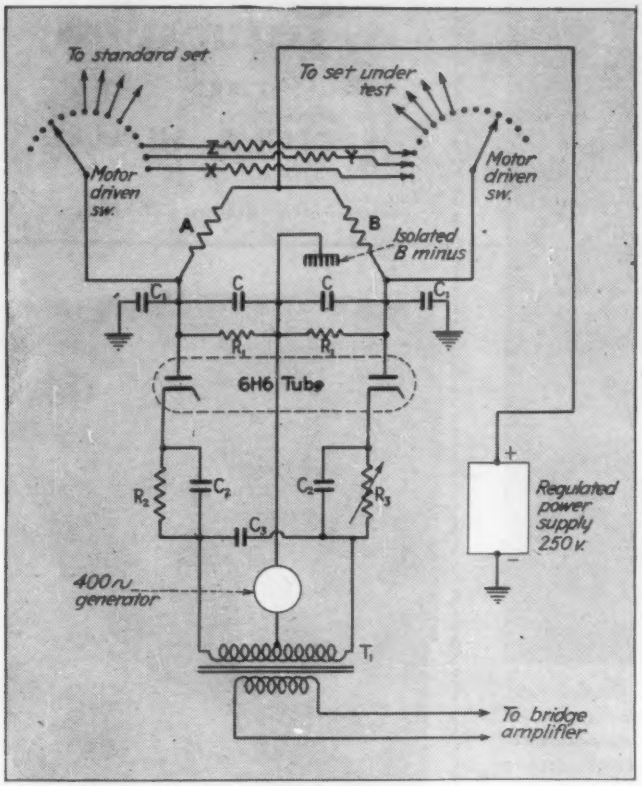
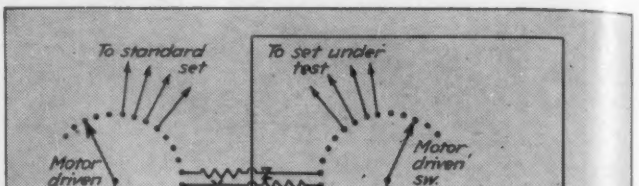


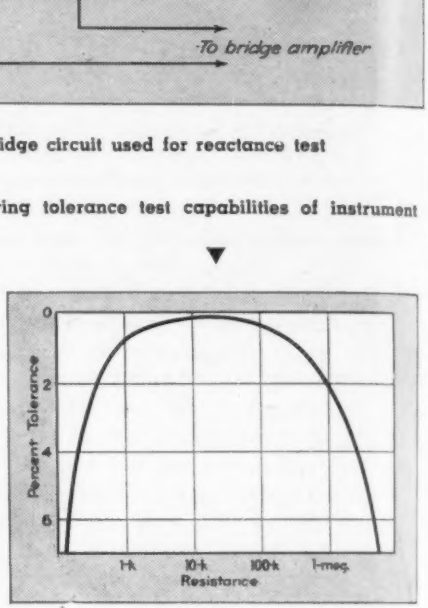
◀ **Fig. 2—Bridge circuit used for resistance test**



▲ **Fig. 3—Bridge circuit used for reactance test**

Fig. 4—Graph showing tolerance test capabilities of instrument

▼



values selected so that the resistance, capacitance and inductance values in each circuit are in the middle of the required tolerance range is plugged into the production testing machine under discussion through a series of cables. As sets of similar design come off the assembly line they, too, are connected to the tester through a group of cables. A motor revolves a rotary switch, successively and momentarily connecting comparable circuits in each set to the bridge. Bridge design is such that each circuit in the set from the assembly line is compared with the same circuit in the standard set from the standpoint of resistance to ground. The bridge circuit is then altered and another motor returns the rotary switch through all circuits back to the starting position, comparing circuit reactances.

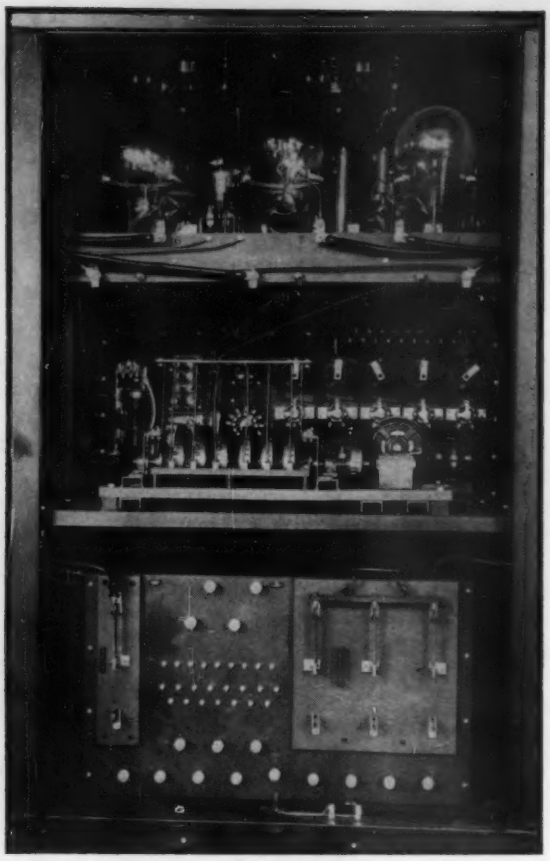
While the tester is making resistance and reactance comparisons any divergence in values beyond the tolerances for which the bridge circuits are adjusted causes the rotary switch to stop. A dial indicates the number of the circuit in which divergence from the standard is encountered. Thus the operator may note down this circuit-identifying number. A re-set button is then depressed, causing the rotary switch to continue its travel until another defective circuit is encountered. Upon completion of this static test the operator has a complete list of numbers identifying circuits which require inspection. If no circuit troubles are encountered up to 120 circuits may be tested for both resistance and reactance in 4 minutes.

It is particularly interesting to note at this point that wiring capacitances within the set under test and in the standard used for comparison are included as part of the reactance test. This is important in many instances. Wiring capacitance in an electronic device may represent an appreciably large percentage of the total capacitance included in a particular circuit.

A block diagram of the automatic production tester is shown in Fig. 1. The bridge circuit comprises two fixed arms, *A* and *B*, which connect by means of a switch arm fitted with two contacts to the other two bridge arms *C* and *D*. Arms *C* and *D* are components in the set under test and the standard set, respectively. Connection to each set is made by way of tube sockets in most cases, although other connections such as antenna posts and output jacks can also be utilized. All circuits are referred back to ground. Several typical circuits which may be tested are included in the block diagram. Tests are not limited to such simple circuits however, but include the majority of combinations of inductance, capacitance and resistance found in electronic equipment.

Equipment Design Details

The production tester is divided into two chassis, the lower one housing two electronically regulated power supplies and audio frequency generators providing a-c for the bridge. One supply provides d.c. for the bridge and power for the audio equipment. The other supply, which is isolated above ground because of



VARIABLE for Testing

Description of an electronic control unit for investigating spot welding conditions in aluminum alloys. It involves both conversion and energy storage principles to produce the various waveforms, and incorporates a number of interesting electronic circuit control aspects

By JOHN W. DAWSON and HANS KLEMPERER

Raytheon Manufacturing Company, Waltham, Mass.

UNTIL the present war period, American practice was to use the ordinary 60-cycle waveform of current for welding aluminum. Step-down transformers, energized for an exact number of cycles, transformed commercial line power to the low voltage and very high current (tens of thousands of amperes) required to spot-weld aluminum by the resistance method. Such practice typically involves 300 or more KVA single-phase line loading. Because aluminum is one of the most critical metals to weld, this high loading must not be allowed to cause more than a few percent drop in line voltage. The installation of more welders by the aircraft industry together with the trend to heavier aluminum sheet gauges further aggravated the line supply problem.

Four years ago an energy storage type welding machine, together with the technique for its use was imported from France (Sciaky Brothers, Co.). The welding current of this machine is a single d-c pulse of from one to several cycles duration, and hence heat is delivered continuously to the weld throughout the time of its formation. The waveform of the current is of relatively steep rising slope followed by a long exponential decay. Subsequent wide adoption of energy storage equipment in America has been due not only to the fact that it solves the line supply problem but also because superior weld quality is obtained.

In 1939 and 1940 American manufacturers of electrical controls and of welding machinery undertook investigations to disclose the best-suited form of energy storage welding equipment together with the ideal conditions for producing the most consistent and highest quality welds in aluminum alloy. These investigations led to so much discussion and controversy regarding the ideal waveform of welding current that the Raytheon Manufacturing Company undertook the development of a special experimental power supply equipment capable of delivering a wide variety of current wave shapes through a suitably designed and co-ordinated welding machine. One of these special control equip-

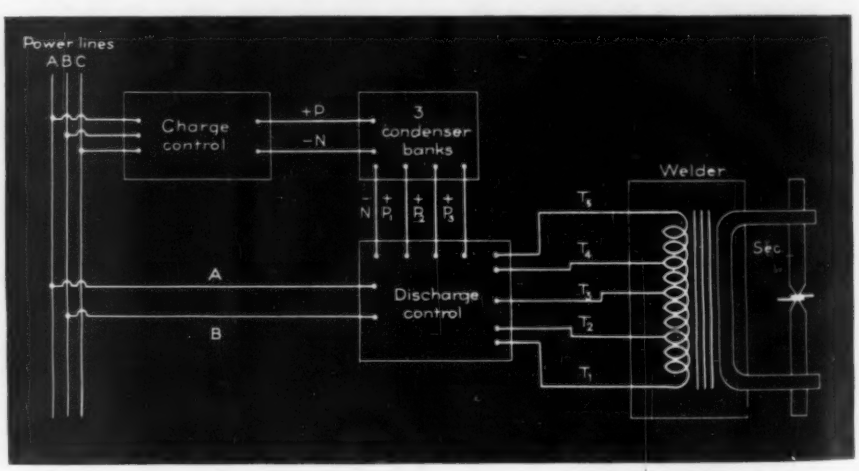


Fig. 1—Principle of the set-up for the experimental aluminum alloy spot welder. Above, left, view of the discharge control cabinet. Note the rotary switch on central shelf

WAVEFORM UNIT
Aluminum Welding

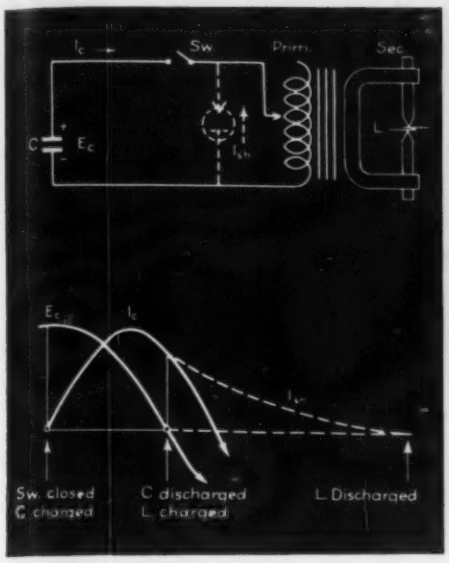


Fig. 2—(left) Principle of operation of the experimental setup

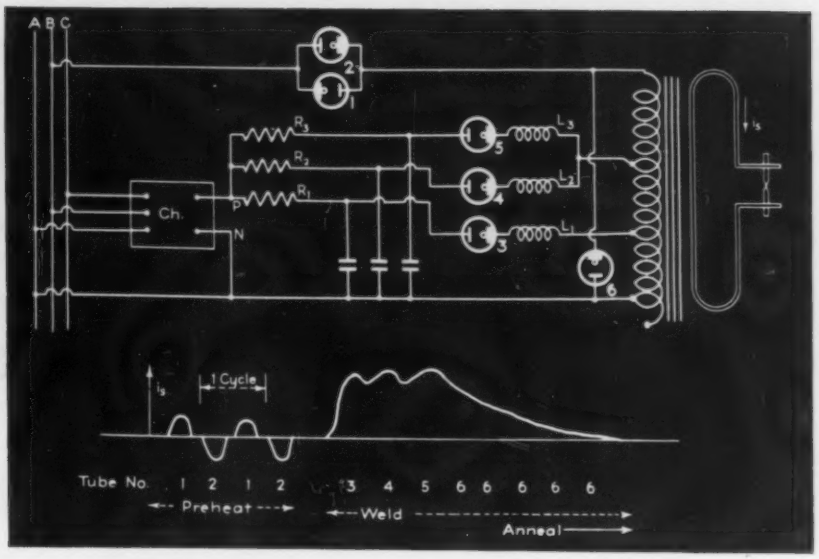


Fig. 3—(right) Means of combining several discharge circuits of the type of Fig. 2

ments was supplied to the Army Air Corps and installed at Rensselaer Polytechnic Institute where investigations of waveform effects on welding are being carried on under the direction of Dr. W. F. Hess. The special welding machine with which the equipment operates was furnished by The Federal Machine and Welder Company.

The variable waveform control unit for aluminum welding investigations consists of the following principal components:

1. Three capacitor banks, each variable for energy storage.

2. An electronically controlled rectifier for charging the capacitor banks to any pre-selected value between 1500 and 3000 volts to within 2 to 3 percent accuracy.

3. A flexible heavy current "discharge" unit consisting of six mercury pool ignition-controlled tubes which discharge the stored energy and may also serve to apply energy taken directly from the line for production of a single weld.

4. A flexible timing assembly containing both synchronous motor driven and electronic circuit means for the various experimental current control programmes.

An outline of the equipment and a graphical illustration of the power flow is presented by Fig. 1. Line power is supplied to a charge-control cabinet which charges the three separate capacitor banks to the predetermined voltage. These three capacitor banks are discharged separately into the welding transformer through circuits provided in the discharge control cabinet. This discharge control cabinet contains six large electronic tubes which can be connected to the power circuits as desired and operated in precisely timed sequence by control equipment in the same cabinet. Additional power can be supplied directly from the supply line through the discharge cabinet to the welding machine. The welding transformer is provided with eight different primary coils which allows a wide selection of turn ratios for each discharge increment. The secondary of of the welding transformer may deliver a current of the order of 100,000 amps to the welding electrodes. The secondary welding circuit "loop", being sufficient to span sizeable aluminum sheet structures when traversed by such a heavy current, stores considerable magnetic energy at the peak value of current. The inductance of this loop appears in the primary circuit magnified by the square of the turns ratio of the welding transformer. It is possible therefore to present to the capacitor banks a very wide range of inductance by variation of the number of transformer primary turns. The natural period of oscillation of the condensers with the welding machine can thus be varied at will.

The discharge circuit of a single condenser bank together with the discharge curves is represented in Fig. 2. The circuit which is shown in solid lines is oscillatory. The early part of such an oscillating discharge is shown by the curves E_c and I_c. With a shunt tube, indicated by dotted lines connected across the welding transformer, the return of energy back through the welding transformer to the condenser bank

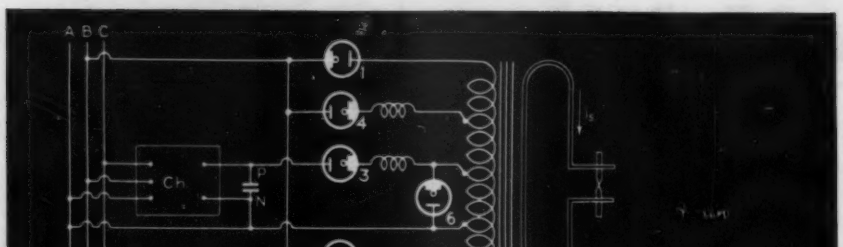


Fig. 4—Means of adding direct current to the weld for purposes of preheating

is prohibited, and that portion of the originally stored energy which is now inductively stored dies out exponentially as shown by dotted lines in the wave diagram. It is thus apparent that the total energy stored in the condenser can be dissipated in the welding circuit as a continuous process, the current decay being shown as dotted line I_s. The rate or the exponent of decay is controlled by the ratio of the inductance to the ohmic resistance of the entire load circuit.

The combination of several discharge circuits of the type shown in Fig. 2 is shown in Fig. 3, illustrating a given current waveform by which energy may be supplied to the aluminum weld. The three capacitor bank are shown, from tubes 1, 2 and 3. One phase of the power line may be applied directly to the transformer through tubes 1 and 2. Tubes 3, 4, and 5 serve to successively discharge the three capacitor banks. Tube 6 prevents the return of energy to the capacitor banks as described previously. The charge control cabinet is represented in block form and labelled *Ch*. Charging current is supplied to each of the capacitor banks through resistors R_1, R_2, and R_3. All banks are charged to the same voltage level, and since the charging time is relatively long, these resistors are made sufficiently high in value that substantially no energy is exchanged between capacitor banks during the relatively short interval over which they are successively discharged.

Tubes 1 and 2 are so controlled that several cycles of energy may be supplied to the welding transformer before the discharge of the capacitors is initiated. As shown in the waveforms of Fig. 3, tubes 1 and 2 can be phase-controlled so as to pass only a portion of the normal half cycle of alternating current. Also tube 1 may be connected to one of the lower taps of the welding transformer whereupon direct current may be applied for preheating the weld. This connection is shown in Fig. 4. Naturally such direct current may be supplied to the welding transformer during only a limited few cycles of rectification in spite of the very large core section provided in the transformer.

After the desired amount in both magnitude and time duration of preheating current has passed through the weld, tube 3 is energized, generally connecting its capacitor to relatively few turns of the welding transformer primary. The turns being few in number, the voltage per turn is relatively high and a steep current rise results in spite of the welding loop inductance. During any portion of the discharge of this condenser bank, another condenser bank may be additionally discharged through tube 4. This can be done through the same transformer turn ratio, or more commonly through a larger turn ratio. When the second bank discharges into a greater turn ratio the rate of rise is decreased and the duration increased. This second condenser discharge increment may now be followed by a third taken from the third condenser through tube 5 in a similar manner. The discharge of the last named condenser bank into the welding transformer is followed by conduction of tube 6. This tube is connected in shunt to part of the primary winding, causing exponential decay of the current and dissipation of the remaining energy.

A great variety of wave shapes can be obtained by delaying the operation of successive discharges. Shunt tube 6 may also be operated between discharges, thus further extending the spacing and further lowering the average level of current. The exponential "tail" may even be delayed beyond the point at which each bank is completely drained and has assumed reverse charge.

Inductances L_1, L_2, and L_3 serve as electric "cushions", preventing sudden current changes and thereby easing the duty of tubes 3, 4 and 5. Without these cushions and assuming that the current commutates for instance, from tube 3 to tube 4 the current flow in tube 3 would immediately cease, leaving the vapor in an ionized state. High inverse voltage would be applied to the tube simultaneously. These conditions would cause considerable ion bombardment of the anode and might result in backfire of the tube, thus short-circuiting the condenser banks. The use of the inductances L_1, L_2, and L_3 improves this condition by reducing the rate of change of current and of voltage of all tubes. Less ionization is thus left following conduction, and a less steep rise in inverse voltage is developed. These protective inductances are designed to saturate at relatively low current and hence influence the current waveforms only at the base and transfer points.

Following the welding current wave, annealling current may be supplied by tubes 1 and 2 in pre-

cisely the same manner in which the preheating current was applied.

Extending the Welding Time

The main welding current wave can also be extended beyond the discharge time of the condenser banks by addition of energy taken directly from the power lines. This mode of operation is shown in Fig. 4. In such operation, after the current has been established by a preceding condenser discharge, the line voltage, rectified through tubes 4 and 5 supplies the losses in the welding circuit. Thus, with the flux in the welding transformer steadily rising, substantially direct current flows through the weld. This current may be allowed to flow for a considerable time which time is limited first by the value of current maintained, secondly by the load ohmic resistance and thirdly by the cross-section of the welding transformer core.

Tubes 1 to 6 shown in Figs. 3 and 4 are of the mercury pool cathode type capable of passing current of several hundred amperes with an arc drop of 10 to 15 volts. The tubes are controlled by an electrostatic igniter. Briefly the igniter consists of a dielectric-covered metallic conductor floated on the pool surface and energized by applying a potential of the order of

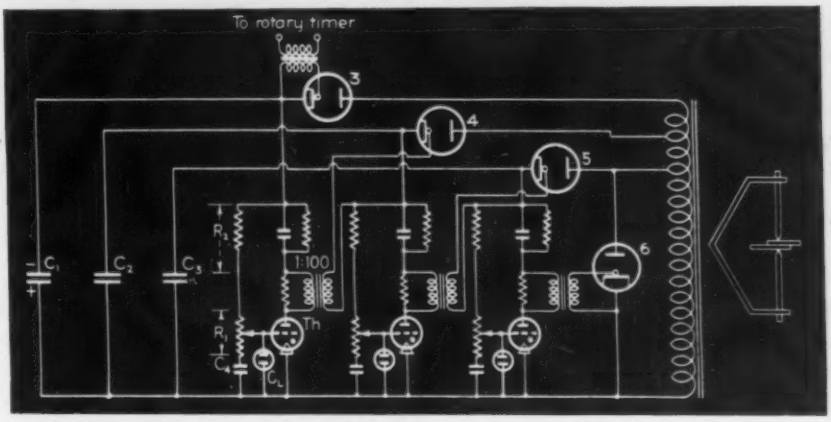
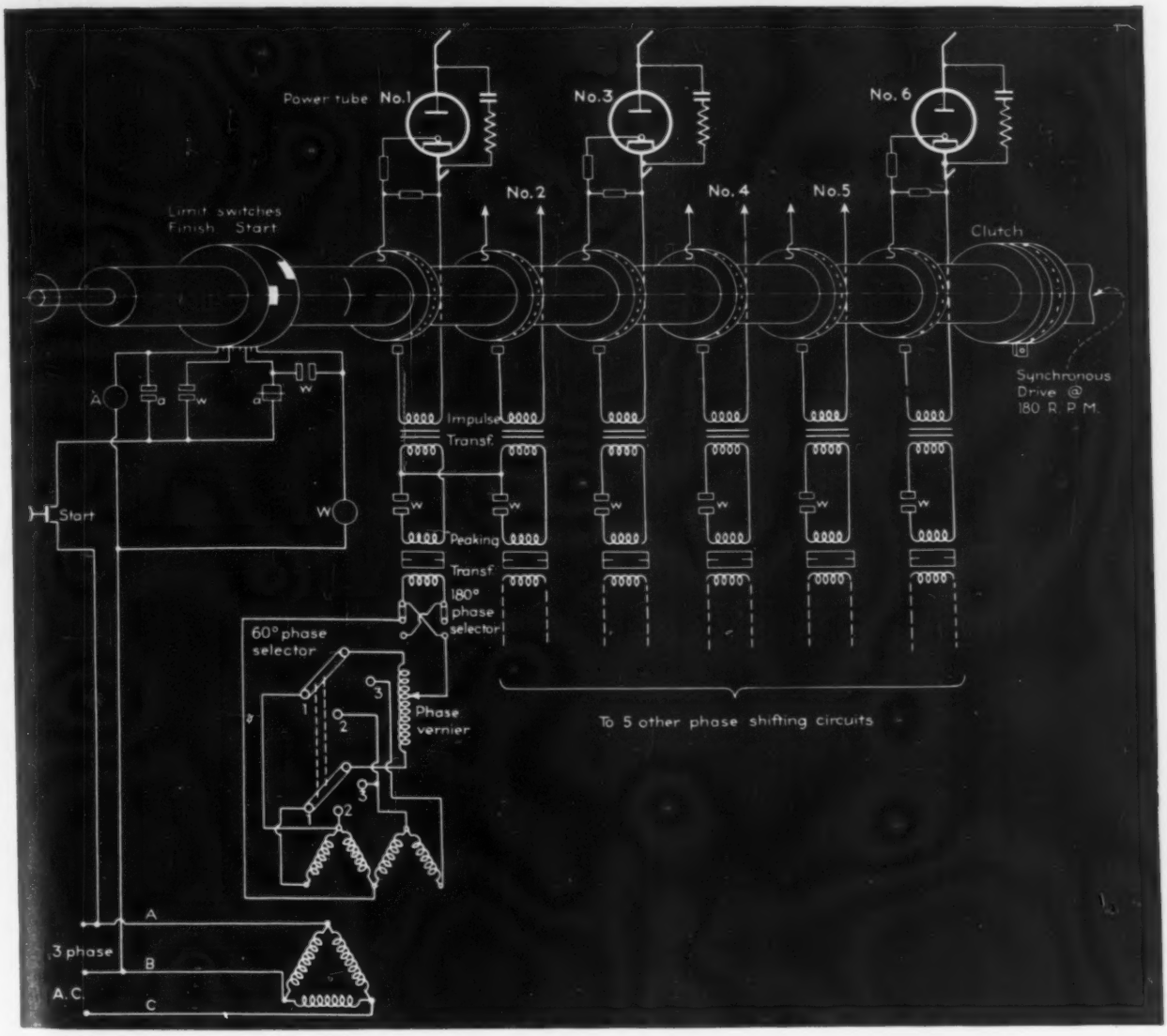


Fig. 5—Rotary timer and distributor

Fig. 6—Electronic ignition delay circuit for triple impulse weld



5000 volts. Since the capacity of the igniter is very small the ignition control power is very small.

Such low control energy level allows considerable flexibility in the types of control which may be employed. The electrostatic ignitor, however, will not maintain a stable cathode spot over a period sufficiently long to allow a stable arc current to build up in inductive load circuits. For this reason, a special pick-up circuit is provided for each tube. The pick-up circuit consists of a capacity-resistance combination between anode and cathode of the tube. This combination delivers sufficient current to maintain the incipient cathode spot until the current in the inductive load circuit has reached the value required for a stable mercury arc.

Details of Timing Control Circuits

Figure 5 illustrates the timing control circuit which include both sequence selection and synchronization with the a-c supply. The rotary drum arrangement includes both the features of the usual synchronous seam welding control and the program selection. The shaft rotating at a speed of 3 revolutions per second, carries 6 program rings. Thus a 20-cycle program is transmitted during each revolution of the shaft. Each program disc carries on its periphery 40 tapped holes in any of which a pointed pin may be inserted. These pins operate against a stationary segment, and close the high voltage circuit by means of a spark. The width of the stationary segment corresponds to ½ cycle of the 60-cycle supply source. Rings 1 and 2 serve to control tubes 1 and 2. Alternating current will be passed by these tubes, as shown in Fig. 3, provided that pins are inserted alternately into even and odd numbered holes in the respective rings.

Ignition voltage is supplied from lines *A*, *B*, and *C*, through a 360-deg. phase shifting circuit composed of tap switches and a sliding contact auto transformer as indicated. This phase-shifted voltage is supplied to a peaking transformer which delivers 50-volt peaks whenever relay contacts *W* (Fig. 5) are closed. This peaked voltage is stepped up by a transformer and will spark over to the program disc pins whenever a rotating pin is passing the

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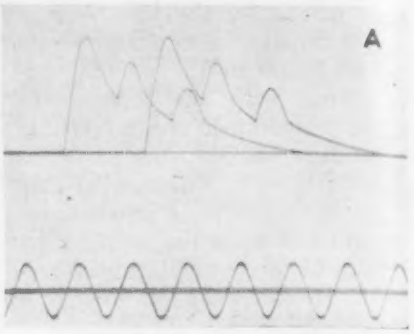
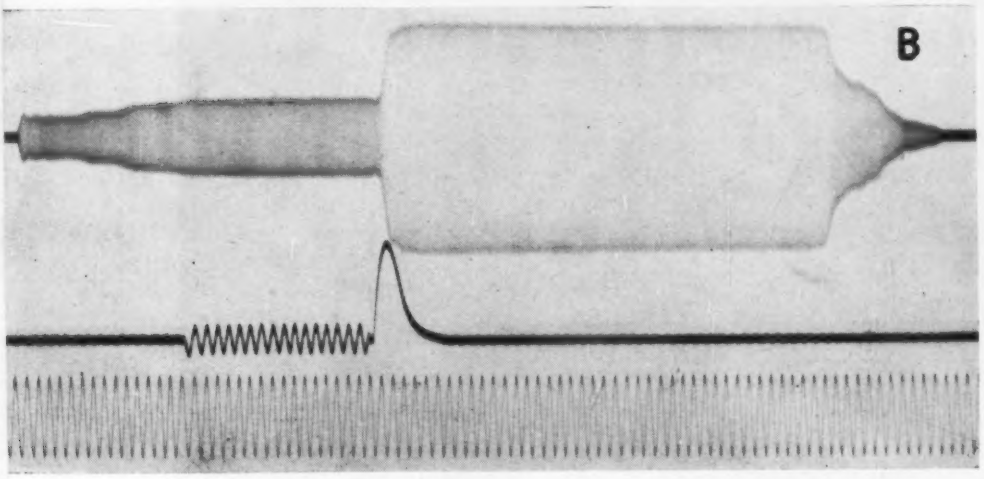


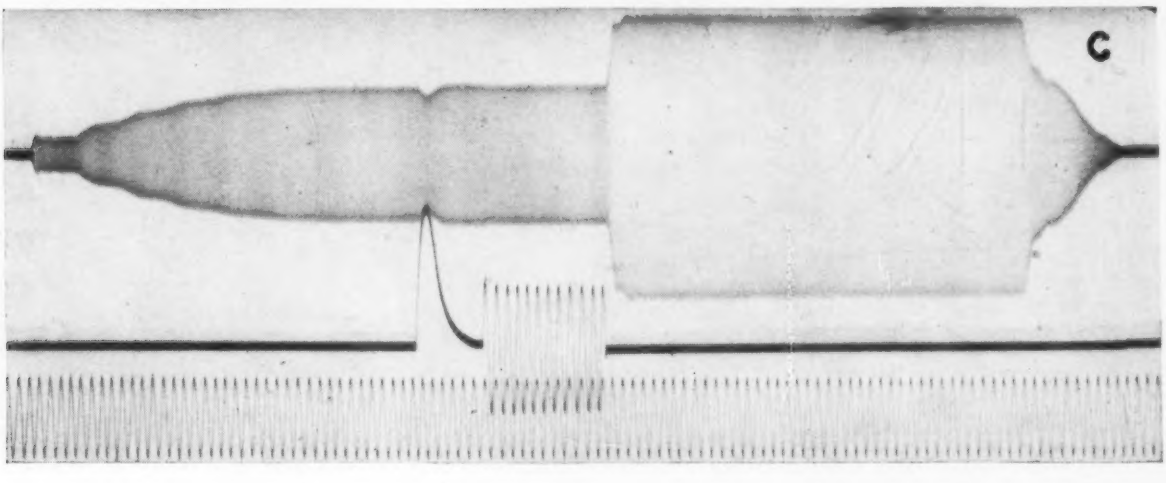
Fig. 7—Some of the waveforms which may be produced with the flexible unit described

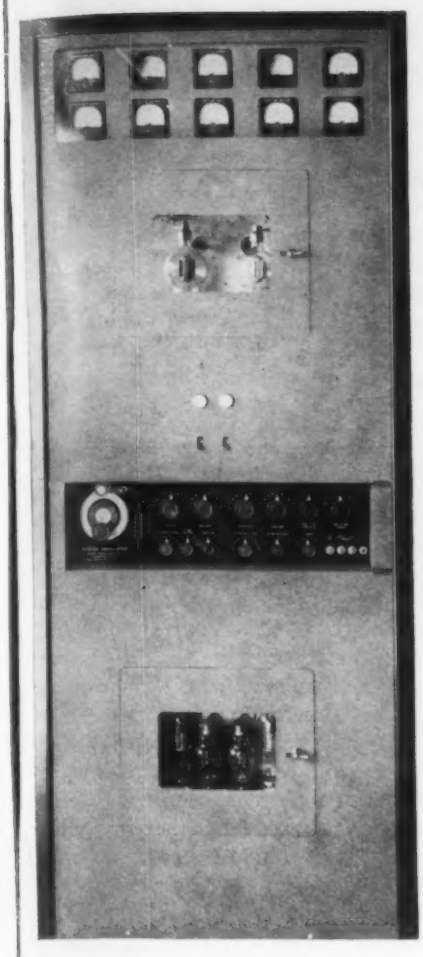


OSCILLOGRAM (a) shows a double exposure of a triple discharge current. To produce this wave the following program of discharge tube firing was chosen; tubes 3, 6, 4, 6, 5 and 6. It will be noted that "artificial" delay was interposed between successive discharges. This wave was produced using the rotary timer. The lower trace is a 60-cycle timing wave

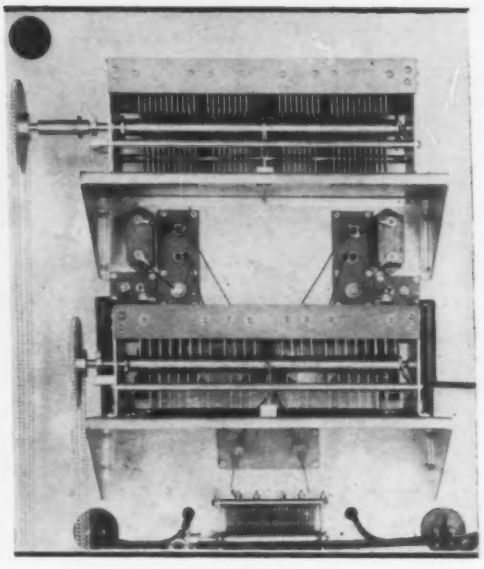
OSCILLOGRAM (b) illustrates an a-c preheating current followed immediately by a single condenser discharge increment. It will be noted that a short delay has been interposed between preheat and welding current to insure that the condenser is not discharged into the supply lines. The upper trace shows pressure of the welding electrodes. The lower trace is a 60-cycle timing wave

OSCILLOGRAM (c) illustrates the application of a-c annealing current





Front view of transmitter built by Harvey Radio Laboratories, Inc., Cambridge, Mass. All controls are on recessed panel near seated operator's eye-level, meters slope downward behind protective glass, final amplifier and power supply tubes may be observed through windows and are readily removable



Rear view of final r-f amplifier chassis. Four-section antenna tuning capacitor (top), similar tank tuning capacitor (center) and grid tuning capacitor (bottom) are operated from the control panel by chains and sprockets. R-f choke jacks are visible between antenna and tank capacitors. Antenna and tank coils plug in from the front

500-WATT CW TRANSMITTER

Radio telegraph equipment of rugged construction and straightforward overall circuit design contains a number of individually simple but collectively important electrical and mechanical features which facilitate operation and maintenance by relatively inexperienced personnel

POINT-TO-POINT radio telegraph transmitters of rugged construction and medium power, covering a wide frequency range and designed along straightforward lines which permit them to be operated and maintained by relatively inexperienced personnel, are in considerable demand.

The 500-watt rig pictured here is typical of this class of equipment, tuning from 1,500 to 30,000 kc in five bands. While the transmitter, considered overall, is necessarily conventional in design it is felt that a number of mechanical as well as electrical features will be of general interest.

Final Amplifier

Examination of the final r-f amplifier circuit shown in Fig. 1 brings to light two design ideas which, while not new to the art, have not been widely employed in this class of equipment.

The tank and antenna tuning capacitors have four separate sections, construction being similar to that of variables used in high-quality shortwave receivers. Plug-in coils are equipped with jumpers which select individual capacitor sections, or parallel combinations of capacity, giving a suitable L/C ratio for each frequency band. The amplifier utilizes a conventional push-pull tank circuit when operated above 13.5 Mc, converts to a pi network arrangement when operated between 1.5 and 13.5 Mc.

Four r-f chokes through which anode current may be shunt-fed to the final amplifier tubes are included in the design. Choke troubles which might otherwise develop due to undesirable modes of resonance at certain points within the extremely wide frequency range which must be covered is avoided by inserting jumpers between tube anode jacks and jacks which select suitable chokes for specific frequency ranges. Number one choke jacks are used for operation between 1.5 and 13.5 Mc. Number two jacks are used between 13.5 and 23 Mc and between 28 and 30 Mc. Auxiliary chokes furnished with the equipment are used as jumpers between anode jacks and number two choke jacks in the range from 23 to 28 Mc.

Although it is not obvious in the diagram, neutralizing capacitors are an integral part of tank tuning capacitor design. This improves circuit symmetry and facilitates short leads.

Fixed grid bias for the final amplifier (and for the driver stage) is

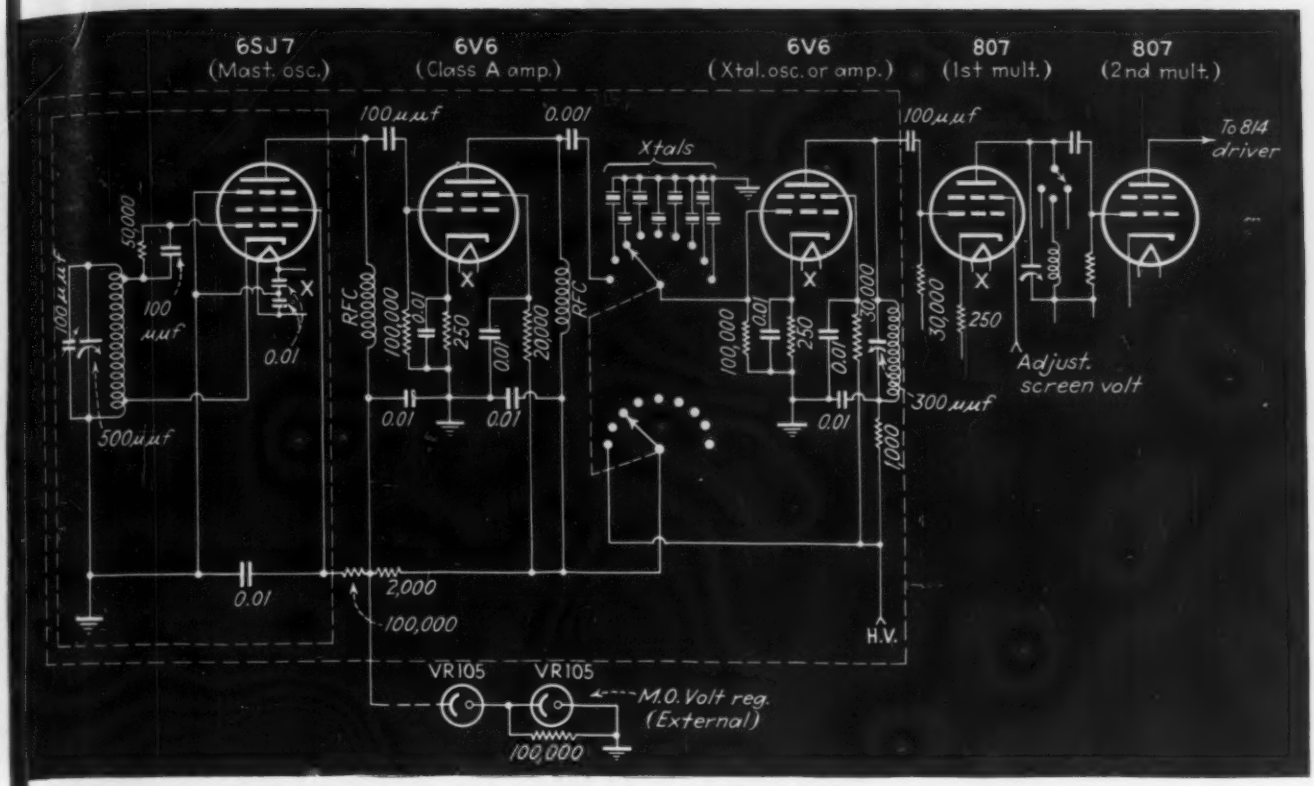


Fig. 2—Exciter circuit. Master oscillator, Class A amplifier and combination crystal oscillator and second amplifier schematics are shown. Voltage is removed from the master oscillator and amplifier when the transmitter is crystal controlled

Keying is accomplished in the cathode circuit of the second multiplier stage. It is handled electronically by passing cathode current for this stage through a pair of paralleled triodes, swinging the grids of these tubes sufficiently negative to cut off anode current when the key is open and sufficiently positive to permit them to pass required multiplier stage cathode current when the key is closed. Key clicks and high voltage at the key are thus avoided. Up to 150 wpm may be transmitted with good output circuit waveform.

A Mu-Switch is put to novel use in connection with a Variac autotransformer included in the transmitter to provide control of tube filament and heater voltages. A conventional time-delay relay prevents anode voltages from being applied until tubes are warmed up but the switch is mechanically linked to the adjustable arm of the auto-transformer in such a manner that even after the time-delay relay operates anode voltage still cannot be applied unless the arm is in a position insuring the application of voltage within 5 percent of rated values to tube filaments and heaters.

Not automatic in operation but interesting circuit provisions nevertheless, are front-panel power supply switches which permit subnormal voltages to be applied to driver and final r-f amplifier stages during the tune-up period. Once all circuits are in resonance and anode current is at the proper minimum these switches may be snapped to the operate position, applying normal operating voltages with the assurance that anode current will not run wild and shorten tube life.—W. MAC D.

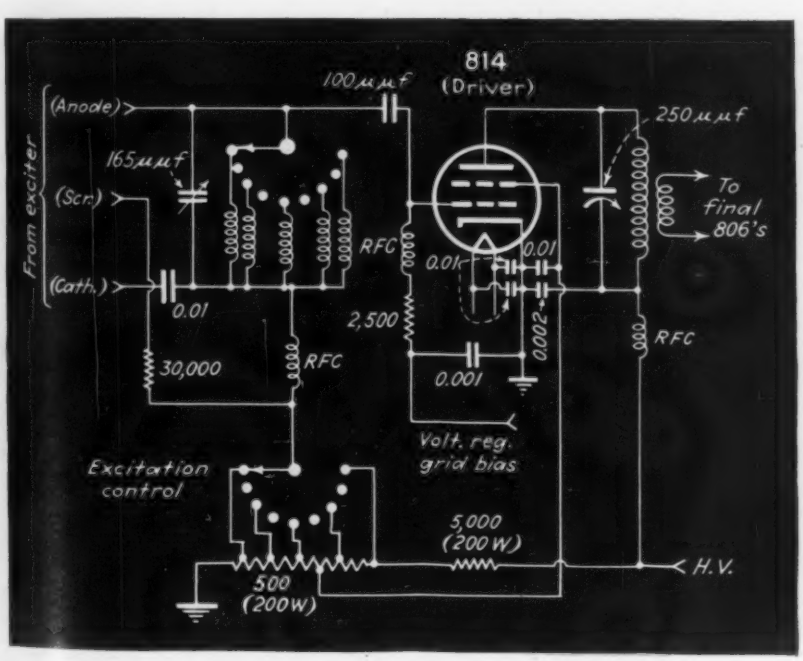
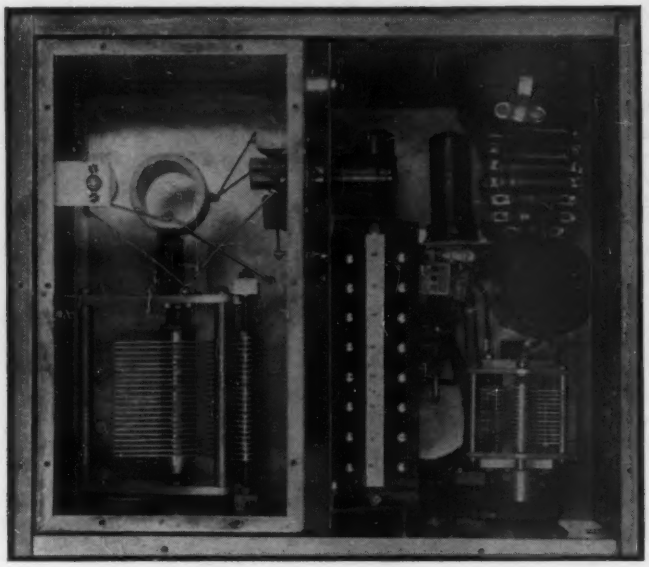
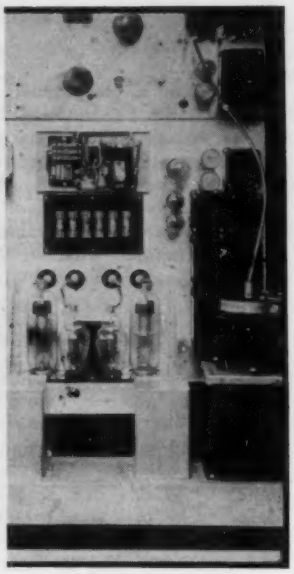


Fig. 3—Driver circuit. Adjustment of the potentiometer permits input to this stage to be controlled without varying tuning



Top view of exciter case. Section at left contains master oscillator circuit. Section at right contains master oscillator tube, Class A amplifier and crystal oscillator



Front view of power supply units. The filament voltage control Variac at the lower right is operated through flexible shafting from the front panel

obtained from a power supply unit equipped with the balanced arrangement of regulator tubes. Use of these tubes in a bridge circuit provides an extremely stable source of bias voltage and at the same time eliminates the necessity for large filter chokes and other power pack components. Bias packs are ordinarily loaded down by low resistance bleeder resistors to secure satisfactory regulation.

Oscillators, Buffer, Multipliers

Referring to Fig. 2, the transmitter contains a master oscillator continuously tunable from 1.5 to 3.8 Mc which, in view of the arrangement of subsequent multiplier stages, permits operation anywhere in the 1,500 to 30,000 kc range. The master oscillator employs electron coupling, obtains anode and screen voltage from a regulated power supply and is built within a shielded compartment which is itself within a larger shielded compartment housing other exciter stages. A high degree of electrical and mechanical stability is inherent in the design.

The master oscillator is followed by a capacitively coupled buffer stage. Buffers are ordinarily Class C operated. This one is designed for Class A operation, the idea being to minimize changes in master oscillator frequency with changes in loading.

The transmitter also contains a crystal-controlled oscillator which may be operated on eight fundamental frequencies between 1.5 and 3.78 Mc, permitting operation on a number of spot frequencies within the 1,500 to 30,000 kc range when succeeding multipliers are properly tuned. It will be noted that the tube used as a crystal oscillator serves as an additional buffer following the Class A buffer described in the preceding paragraph when the master oscillator is in use. It will also be noted that anode and screen voltage supply to the master oscillator and Class A buffer stage is removed by an auxiliary switch arm when the crystal spot frequencies are in use.

Driver and Other Features

The circuit of the driver stage immediately preceding the final r-f amplifier is shown in Fig. 3. The chief point of interest here is the use of a variable voltage divider providing control of driver excitation by permitting variation of the voltage applied to the anode and screen of the preceding multiplier tube. The divider also serves as a stable source of screen voltage for the driver itself. Variation of second multiplier anode and screen voltage (and variation of first multiplier screen voltage by similar means) permits adjustment of excitation without upsetting circuit tuning, which would occur if variable capacitive or inductive coupling was used.

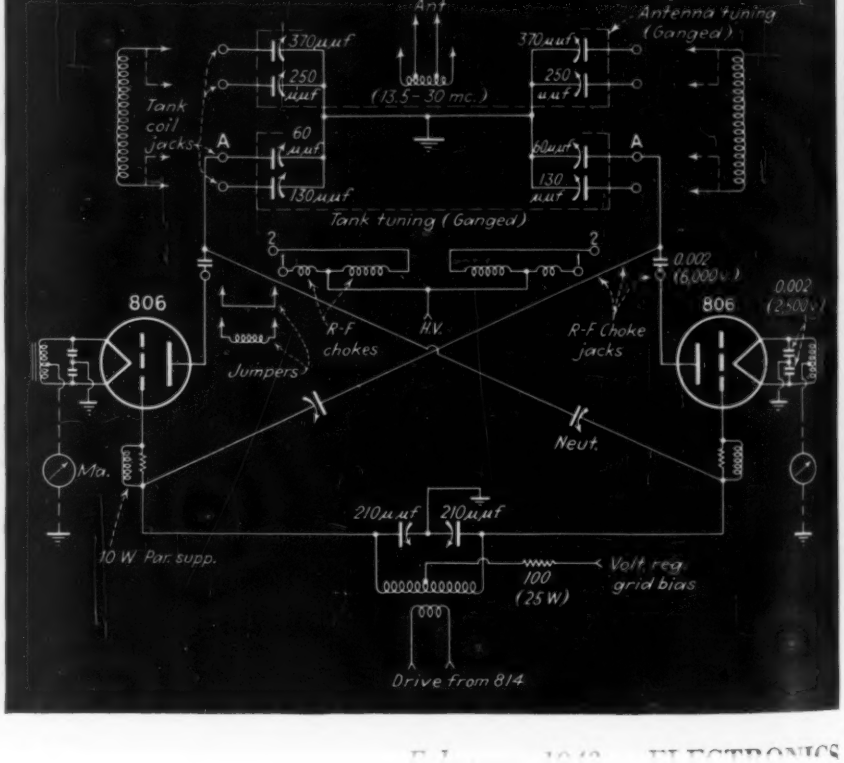


Fig. 1—Final r-f amplifier circuit. Antenna and tank coil plugs automatically select proper *L/C* ratios for each of five bands. R-f chokes suitable for the various bands are selected by moving jumpers between jacks

RELAYS

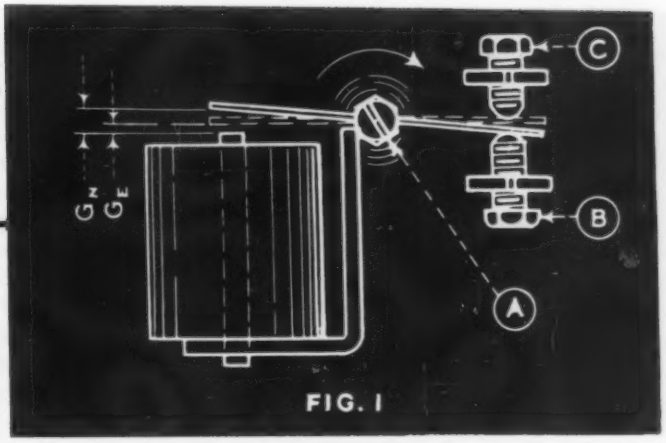


FIG. 1

Details of a relay of the type described

fied form a sensitive relay of balanced armature (center pivoted) design. Subsequent discussion would hold true equally well for any other design provided the same definitions are used. Any relay is, of course, a device for comparing a variable (the input current) with a constant (the spring force) and getting an effect dependent on which of these is greater. The input current is translated into magnetomotive force by means of an electromagnet. When the magnetically permeable armature is placed in the field of this magnet in any position similar to that shown, this magnetomotive force is translated into a mechanical force acting on the armature in the form of a torque opposite in direction from that of the spring. The spring force in the figure is shown by the curved arrow. In *any given position* of the armature this torque due to magnetism is a function of the current in the coil. Any electrical engineer is familiar with the laws governing this phenomenon, in that the force also depends on the permeability of the iron circuit as determined by the particular gaps at the moment. He will need only to be reminded of the effect of these laws as applied to the adjustment and operation of the relay.

In any given position of the armature this magnetic torque will equal the spring torque at a certain value of input current. At, or above this value, if the armature is free to rotate in such a direction it will rotate as from the solid to the dotted position in the drawing.

But now having swung toward the magnet, the armature has shortened the air gap in the magnetic circuit, thereby increasing its permeability and likewise the torque acting on the armature which is now a different and greater function of the magnetomotive force (or ampere turns) in the coil; the response of the relay to the comparison between coil current as a variable and spring tension as a constant will now be on a different basis.

As the input current is decreased, before the spring torque can again equal the magnetic torque and take control, restoring the armature to normal position (relay de-energizing) it will be necessary to reduce the input current considerably below the value at which the relay energized. It can easily be seen that this is true even if the effect of hysteresis or retentivity in the iron magnetic materials is negligible.

The difference between the value of input current at which the relay will energize and that at which it will de-energize is known as the operating differential. It is often described by the percentage of the former represented by the latter.

It is not difficult to see, even if one were not previously conscious of the fact, that the operating differential must be some sort of function of the amount of motion permitted the armature as compared with its original position. While in theory this function can easily be derived, in practice its exact expression has little importance, particularly as many factors of relay design operate to destroy its simplicity. The generalization which is important is that roughly speaking, and again referring to the drawing, the greater the difference between the gap represented by G_N and that represented by G_E the greater will be the operating differential. Conversely the nearer unity approached by the expression $\frac{G_E}{G_N}$, the nearer the de-energizing current will approach to 100 percent of the energizing current.

Three Basic Adjustments

The operation of the three basic adjustments provided on a sensitive relay can now be made clear. In the first place they are:

A. Amount of spring tension.
B. Position of normally closed contact.
C. Position of normally open contact.

If we assume a constant setting of spring tension (controlled by turning stud *A*), it will be seen that the position of normally closed contact *B* defines the normal position of the armature, and hence by defining *normal* conditions in the magnetic circuit, the position of contact *B* controls the value of input current at which the relay will energize. To be emphasized is the fact that the setting of the normally open contact *C* has absolutely no effect on this value.

On the other hand, we can see that the setting of contact *C* determines conditions in the magnetic circuit when the relay is energized by limiting the rotation of the armature toward the magnet. The movement starting with armature resting against this contact is, of course, de-energizing. Therefore the position of contact *C* controls the value of input at which the relay will de-energize. In this case it is to be noted that contact *B* has no effect whatever on the de-energizing value.

The setting of the spring obviously affects both values, an increase in tension requiring more input to energize the relay, and permitting the relay to de-energize at a value greater than before. It will appear that at widely different settings of

ADJUSTING SENSITIVE R

By R. T. FISHER

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IN the course of recent months it has become increasingly evident that many engineers engaged in the design and production of electronic control equipment wherein use is made of sensitive relays would be aided considerably in their work by more familiarity with the principles by which such relays are adjusted. These principles deal with phenomena so simple as hardly to merit consideration as problems of electrical engineering; yet, perhaps because of that very fact, or because of their not-quite-so-obvious interrelationships, we have found that a good deal of work is being done in the dark.

Typical Circuit Requirements

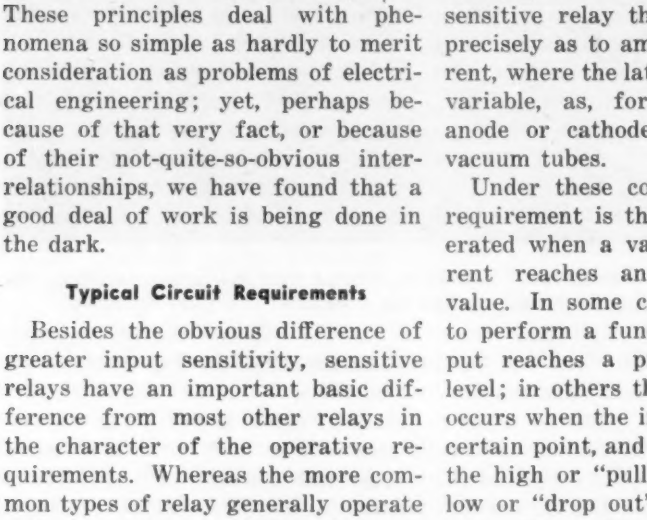
Besides the obvious difference of greater input sensitivity, sensitive relays have an important basic difference from most other relays in the character of the operative requirements. Whereas the more common types of relay generally operate under just two conditions between which their action must discriminate, namely with and without input current, it is often required of a sensitive relay that it discriminate precisely as to amount of input current, where the latter is continuously variable, as, for example, in the anode or cathode circuits of high vacuum tubes.

Under these conditions the basic requirement is that a switch be operated when a varying control current reaches an arbitrarily fixed value. In some cases the relay has to perform a function when the input reaches a predetermined high level; in others the desired function occurs when the input drops below a certain point, and in still others both the high or "pull-in" point and the low or "drop out" point are important. To avoid confusion we shall speak of relays as "energizing" (on a high input) and "de-energizing" (on low input). We shall refer to contacts as "normally closed" or "normally open" in the de-energized state. A relay may of course have both. Even when it does not have both contacts, the one which is absent must be replaced by a "stop" limiting armature travel in that direction, and for purposes of discussing adjustment, it will be convenient to refer to this stop as a contact.

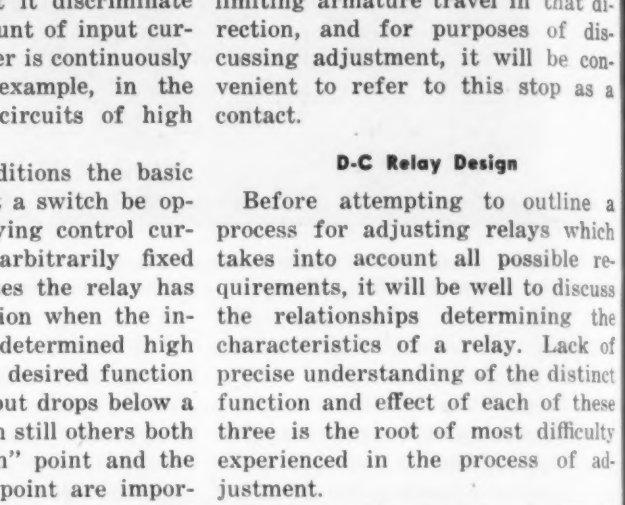
D-C Relay Design

Before attempting to outline a process for adjusting relays which takes into account all possible requirements, it will be well to discuss the relationships determining the characteristics of a relay. Lack of precise understanding of the distinct function and effect of each of these three is the root of most difficulty experienced in the process of adjustment.

In the drawing is shown in simpli-



Checking contact pressure of relay with sensitive torque meter



Using paper gage to set normally open contact gap

the spring, identical values for energizing and de-energizing currents could be secured by changing the adjustment of the contacts. This is perfectly true, the choice being made in terms of other factors as will hereinafter appear.

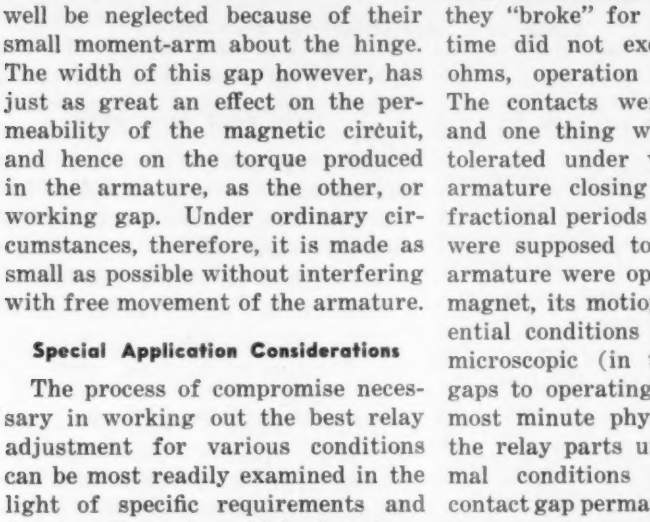
One other adjustment which is normally made only by the manufacturer is the size of the air gap nearest the hinge where motion of the armature is small and where forces developed by magnetism have not been considered. These forces may well be neglected because of their small moment-arm about the hinge. The width of this gap however, has just as great an effect on the permeability of the magnetic circuit, and hence on the torque produced in the armature, as the other, or working gap. Under ordinary circumstances, therefore, it is made as small as possible without interfering with free movement of the armature.

Special Application Considerations

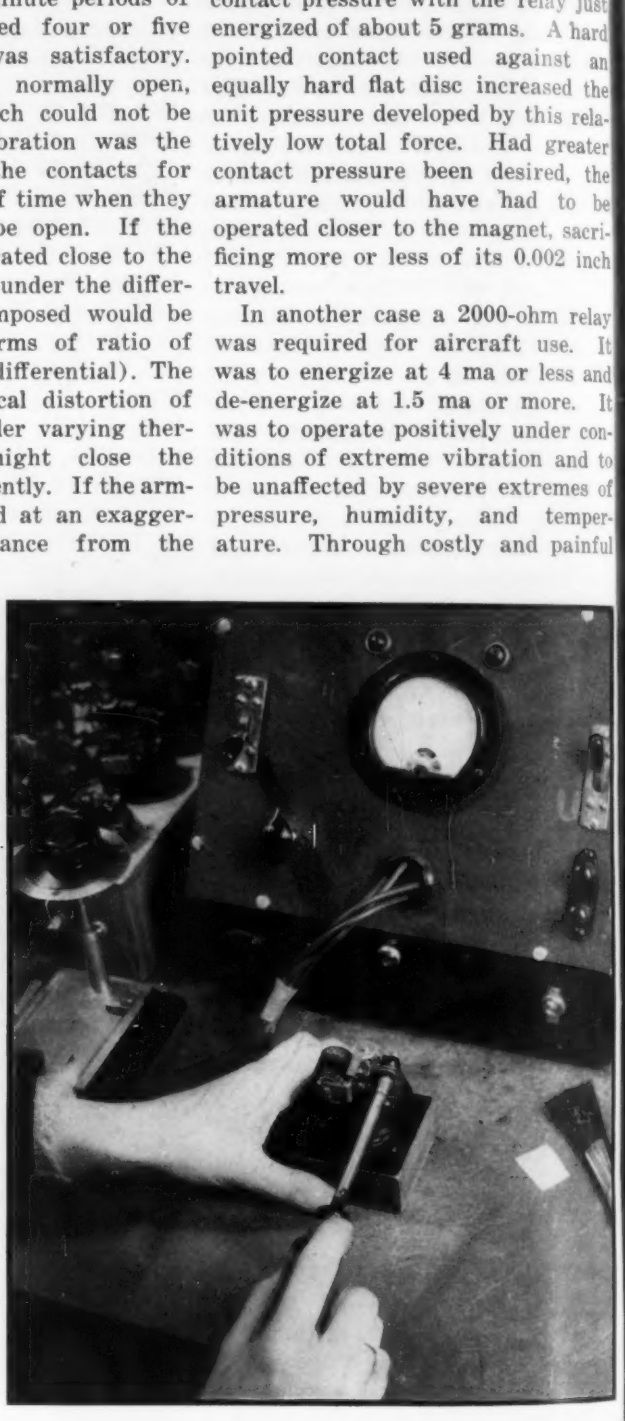
The process of compromise necessary in working out the best relay adjustment for various conditions can be most readily examined in the light of specific requirements and the expedients by which they have been satisfied.

One manufacturer specified a relay with a 5000-ohm coil to energize at 4 ma. As sensitive relays go, that is a relatively large amount of input. But wait a minute! It must operate with a differential of only 0.2 ma or about "95 percent drop out." As the relay was for use in aircraft radio equipment it would be subject to more or less severe vibration; on the other hand its "load" was a high impedance circuit such that if under vibration the average resistance of the contacts as they "broke" for minute periods of time did not exceed four or five ohms, operation was satisfactory. The contacts were normally open, and one thing which could not be tolerated under vibration was the armature closing the contacts for fractional periods of time when they were supposed to be open. If the armature were operated close to the magnet, its motion under the differential conditions imposed would be microscopic (in terms of ratio of gaps to operating differential). The most minute physical distortion of the relay parts under varying thermal conditions might close the contact gap permanently. If the armature were operated at an exaggeratedly great distance from the magnet, the spring force as well as the magnetic force would have to be so small as to cause unreliable operation, although the gap would be more appreciable. The compromise finally worked out provided a working air gap of about 0.030 inch with about 0.005 inch at the hinge. Armature travel, measured at the contacts, to give required differential was approximately 0.002 inch with 0.0015 inch as a minimum. The setting of the spring permitting operation under these conditions resulted in a contact pressure with the relay just energized of about 5 grams. A hard pointed contact used against an equally hard flat disc increased the unit pressure developed by this relatively low total force. Had greater contact pressure been desired, the armature would have had to be operated closer to the magnet, sacrificing more or less of its 0.002 inch travel.

In another case a 2000-ohm relay was required for aircraft use. It was to energize at 4 ma or less and de-energize at 1.5 ma or more. It was to operate positively under conditions of extreme vibration and to be unaffected by severe extremes of pressure, humidity, and temperature. Through costly and painful



Third step in adjusting relay. Setting spring for drop-out at indicated current



Step four—setting normally closed contact for correct pull-in value

experience it was found that nothing less than the maximum contact pressures attainable with the particular relay to be used would give adequate performance under vibration. This required the use of the smallest practical air gaps. That at the hinge was kept between zero and 0.005 inch. The working gap, in the energized condition was between 0.0025 and 0.0035 inch; about double this value in the normal state. Although this resulted in adequate contact pressure even on the normally closed contact to effectively combat vibration, the relay as a whole represented an unfortunate compromise. Because the load (1 amp at 16 volts d.c.) was inductive, the contractor attempted to use a condenser across the small contact gap to prevent continuous arcing at high altitude conditions. This caused such heavy inrush currents when the contacts were closed—discharging the condenser on short circuit—that welding occurred causing intermittent operation. It was necessary to add a resistor of about 100 ohms in series with the condenser to prevent this. A more serious effect of the uniformly small gaps used throughout was the tendency of the relay to change its operational adjustment at extremes of temperature. Slight but unavoidable physical changes occurring under these conditions resulted in significant disturbance of the various relationships which, as we have seen above, determine the operation of the relay. All these things added up to high percentages of production rejects with resultant wasting of scarce materials and higher unit cost, as well as a likelihood, greater than necessary, of failure in service of a unit on which a very great deal depended.

As we later discovered, had there been adequate consultation at the outset, it would have been perfectly possible to provide more input current or voltage which would have resulted in a vastly superior meeting of requirements. As so often happens to the great distress of all, samples were requested of a 2000-ohm relay set to operate at the values mentioned above. As this was perfectly normal, samples were furnished. When the manufacturer had tested the samples to a certain extent, during which tests the defects described above failed to develop, the design of the whole equipment was frozen. After that, it was not until several thousand dollars worth of relays were scrapped and a lot of invaluable time lost that even the partially satisfactory solution described in the paragraph above was provided.

Gaps and Contact Pressure

A process of trial and error is, therefore, necessary in many cases before the optimum possible adjustment for securing a given result with a given sensitive relay can be determined. In general, for severe contact loads or severe vibration, heavier contact pressures are necessary. The smaller the working gaps in the magnetic circuit the more contact pressure and the less motion. This is true not only for the normally open contact but also for the normally closed contact, since here the spring pressure de-energized equals the magnetic force at the instant of energizing, and the magnetic force will be large only if the normal position of the armature is close to the magnet. For greatest speed of relay action some intermediate gap, providing fairly low inductive reactance and smaller time lag in the coil, and yet providing moderately positive action may be best. Summing up, the smaller the gaps, the more contact pressure and resistance to vibration; on the other hand, the worse the effect of physical distortion, the less the separation of the contacts for a given differential and the slower the relay will operate (in terms of microseconds). There is, therefore, no way of avoiding some form of compromise, except to provide sufficient margins of safety as suggested by the relay manufacturer.

After the desired adjustment has been ascertained it can be readily duplicated, in cases where the relays must be adjusted by the user, by a process such as the following. Although this process is adapted specifically to Sigma relays, it would apply with modifications equally well to any other sensitive relay.

Step-by-Step Method

If it has been found necessary to use small working gaps for maximum contact pressures, a slip of paper is selected with thickness equal to the air gap desired at the end of the armature when the relay is energized. The steps in adjustment are then:

1. Insert paper gauge between armature and magnet. Energize coil sufficiently to hold armature firmly against paper and magnet.

2. Advance normally open contact (*C* in the drawing) until it just closes (electrical indication, such as ohmmeter or small lamp, is necessary). See that paper is still held firmly between armature and magnet. The working air gap for energized position is now set. The normally open contact is not moved again. (If comparatively wide gaps are in order instead of using the paper shim, any other convenient gauge is employed in much the same manner.)

3. Pull out paper gauge and reduce input to value at which it is desired that relay de-energize. Increase spring tension until armature drops out. Re-energize and check again.

4. Increase input to value at which relay is to energize. Screw in normally closed contact (*B* in drawing) until armature pulls in, opening normally closed load circuit. Reduce input, de-energize relay, then slowly increase again to check.

The relay is now completely adjusted. The contact pressure in both positions will be within the established limits if the gaps have been adjusted successfully.

A-C Relay Adjustment

Sensitive relays for operation on a.c. from 60 to 3000 cycles are adjusted on slightly different principles. First, let us recall the main difference between an a-c relay and its more common d-c counterpart. To prevent the armature coming and going with each peak of current causing an intermittent buzzing contact, the pole of the electromagnet on the a-c relay is divided into two faces. About one of these is placed a solid continuous turn of copper (in some cases, more turns are used). This is known as a shading coil and the pole face on which it is placed as a shaded pole. The effect is that when the flux caused by the a-c in the main coil is passing zero and changing most rapidly, a peak of induced current occurs in the shading

(*Continued on page* 200)

The Flux N

By D. D. JONES

Columbia Broadcasting System, Inc.
Engineering Department
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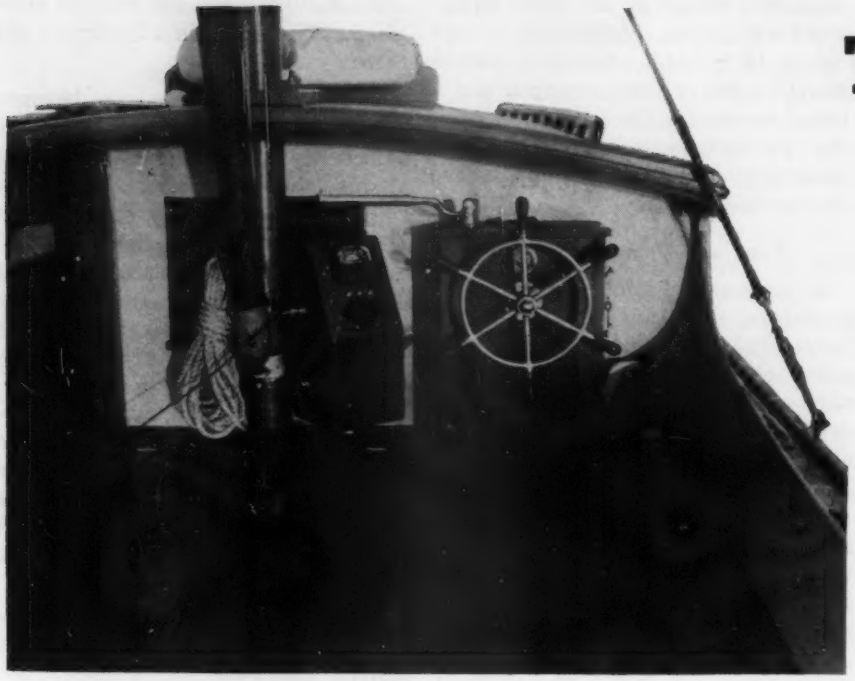
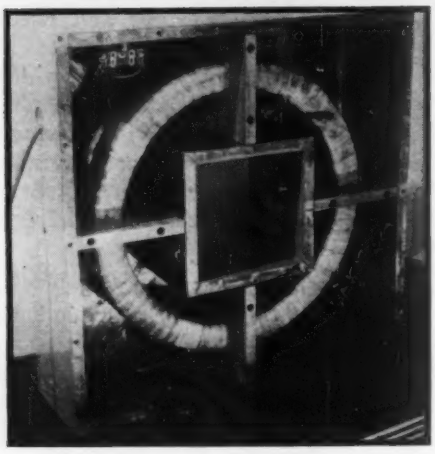
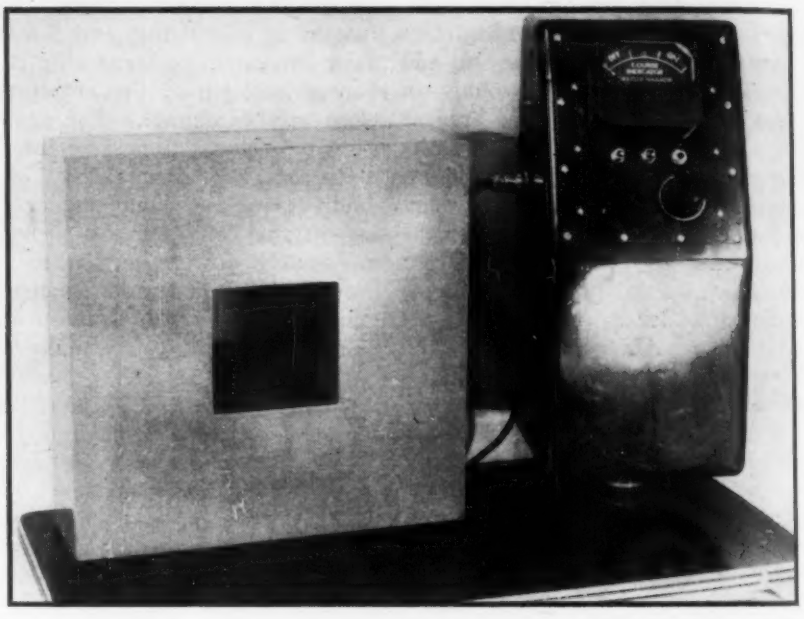


Control box and course-indicating meter are located next to wheel when installed on shipboard





Interior view of pickup loop (above) with completely enclosed loop and course indicator ready for installation (right)

IN restricted waters the magnetic field surrounding a loaded submarine power cable may be used very effectively as an aid to navigation. This fact is of particular importance in places where there is occasional heavy fog and water traffic must be maintained.

Recently, one of the largest broadcast transmitters in the United States was erected on a small island in a region which, at intervals during certain months of the year, becomes totally obscured in dense fogs of long duration.

For efficient operation in all weather, a transmitter so located requires regular and dependable ferry service. Primary power is supplied to this island by means of two heavily armored polyphase submarine cables, only one of which is loaded at any time. Since the route used in laying the cables is approximately coincident with the course charted for the ferry, a sound practical basis was established for development of the "flux navigator."

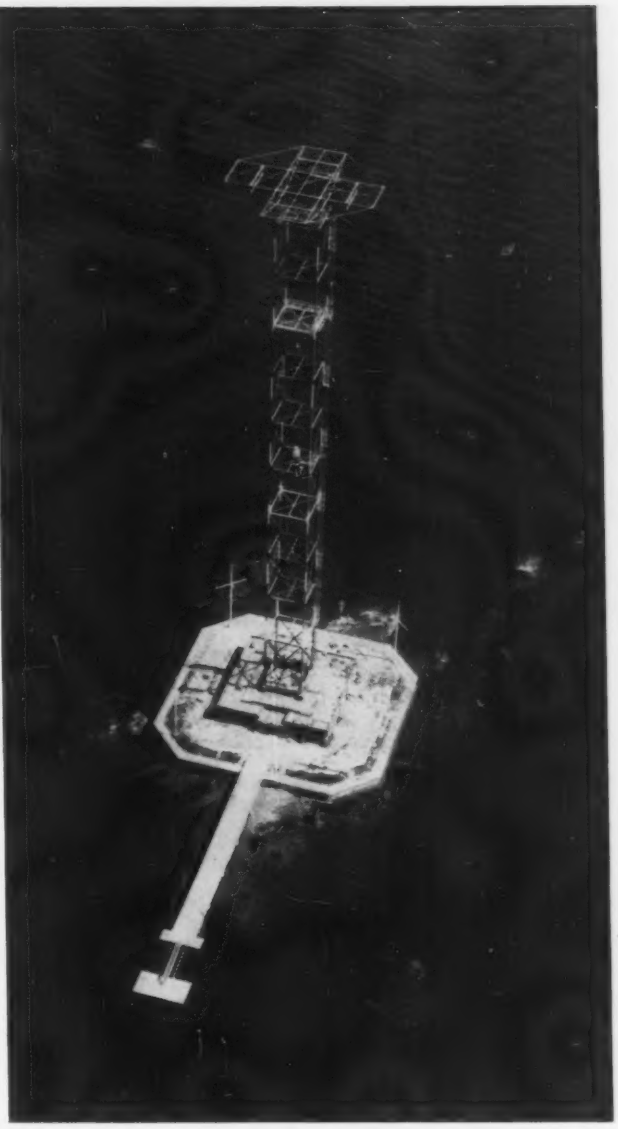
General principles

Each power cable is routed in a separate channel leading to the island and each channel is sufficiently deep at mean low water to permit small boat navigation with safety.

The flux of the magnetic field surrounding the loaded cable generates an e.m.f. in the loop circuit of the flux navigator. This energy, a large component of which is 180 cycles, is then amplified, rectified and impressed across the terminals of an indicating meter. In effect, this device is like a flux meter except that it is designed for use in very weak fields, provides an audible signal when and if needed in emergencies and, being mechanically rugged, is

NAVIGATOR

CBS engineer designs electronic navigating device to aid WABC's operating personnel to reach island on which transmitter is located, even in severe fog. Magnetic field from cable feeding power to broadcast station directs route of vessel



General view of WABC's tower and transmitter house on Columbia Island, with landing pier in lower left corner

well adapted to navigational purposes.

Experimental runs have demonstrated this method to be simple, reliable, and surprisingly accurate. On some of the first experimental tests it was found advisable to locate and trace each submarine cable from the island to the splice point on the mainland. The information so obtained has been prepared in map form and is available for future reference.

Single loop system

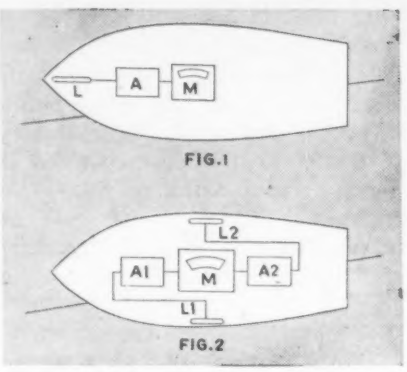
The essential elements of a single loop system are shown in Fig. 1. This is the arrangement which is now being used in the permanent equipment on board the boat. In Fig. 1, *L* is a large coil, the characteristics of which will be explained, *A* is an RCA type 62-A portable amplifier which has a voltage gain of 86 decibels and *M* is the volume indicator which is conveniently used as a course indicator. With the single loop system, the gain through the amplifier is adjusted so that "On Course" is indicated by maximum deflection of the pointer.

The voltage gain required for either cable was determined by experiment. Gain adjustments are not critical and, in general, depend upon the topography of the ocean floor which naturally determines the spacing between the loaded cable and pickup coil.

The magnetic field intensity (*H*) varies directly with current and is inversely proportional to distance,

Fig. 1—Diagram of arrangement of flux navigator equipment using a single pickup loop. Vessel is guided by steering for maximum meter deflection

Fig. 2 — Diagram of two-coil-pickup flux navigator capable of providing "Port — On Course — Starboard" indications



so that as the boat approaches the cable from any angle the field intensity at the loop increases and there is a very marked increase* in meter deflection as the boat gets within a few feet of the cable.

For the greater part of the total length, the cables supplying power lie at a depth of 15 to 30 feet and, in one section, the cable used for emergency supply lies at a depth of 50 feet at mean high water. It becomes evident that the sharpness of indication at *M* for a given cable current will depend upon the depth of the water at any point. Since readings on the meter show field intensity (*H*) only, there is no direct indication of the "port" or "starboard" sense and there is, of course, the exceptional possibility of making a 180-deg. error. The lack of port and starboard indication is no serious disadvantage, however, because the meter pointer can deflect to maximum only when directly over the cable and the boat is steered for maximum deflection with perhaps a continuous slight weaving along the course.

* The meter reading reduces from full scale to half scale for a deviation from the course equal to the depth of the cable.

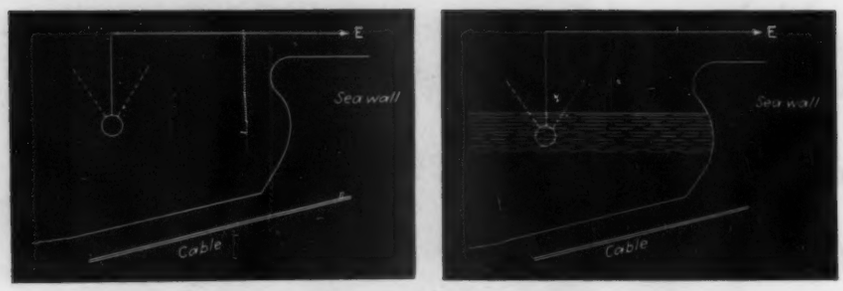


Fig. 3—Experimental set-up for determining effect of appreciable body of water between power cable and pickup coil in non-magnetic vessel. Fig. 3A (left)—Low tide conditions. Fig. 3B (right) Water at high tide

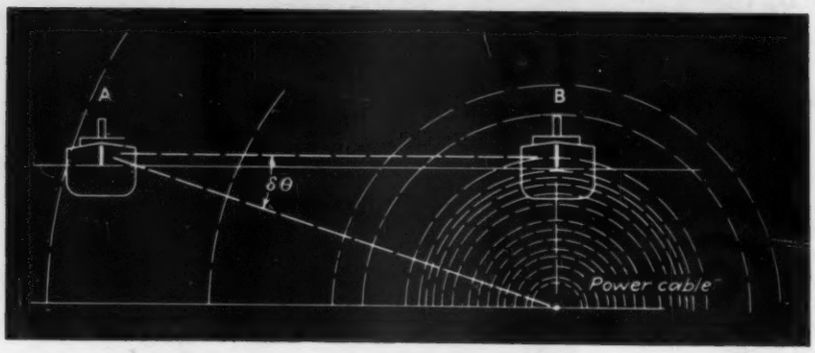


Fig. 4—By orienting the pickup loop in a vertical plane, ignition and engine noise is reduced to a minimum; pickup from power cable is a maximum

The single loop system appears to be the simplest practical arrangement for detecting and navigating the cable and requires no special knowledge for its operation.

Balanced loop system

To provide direct "Port—On Course—Starboard" indication, an equipotential or balanced loop system was designed but experimental development has not yet been completed. This system is shown in the block schematic of Fig. 2.

When the induced voltages in L_1 and L_2 are equal (regardless of phase relationship) the meter M reads "On Course." The on course condition prevails only when the longitudinal axis of the boat is in the vertical plane of the cable. Two induction coils are used, one each for port and starboard pickup. Each coil feeds an associated amplifier and the output of each amplifier is fed into a balanced vacuum tube rectifier bridge circuit which has a differential type d-c milliameter for the unbalance indication.

The voltage gain through A_1 is adjusted for equality with the gain through A_2. When the boat is exactly on course, the amplified signal, appearing across either input of the balanced rectifiers, is the same and the unbalance current in the bridge is zero. The meter then reads on course. Any movement of the boat out of the vertical cable plane results in a voltage difference across the terminals of L_1 and L_2 and an unbalance current flows in the bridge circuit.

The direction of current flow provides direct reading of the sense of deviation, i.e., a movement of the boat to the left or right of the vertical cable plane will cause corresponding movement of the meter pointer to port or starboard. This statement, of course, holds true only when the boat operates within a rather limited area of the useful field and where there is still enough input signal to keep the equipment in operation. A careful search for reference material on the subject of flux navigation was made while experiments were in progress. No such material could be found. As a result of the experimental work, however, sufficient data has been accumulated to permit handling of the design in a straightforward manner.

The practical aspects for the completed design of either a single or balanced loop system will now be dealt with briefly.

Quite naturally, the first consideration in the design of flux navigating apparatus must be given to the nature and extent of the flux available. Means were unavailable for measuring the field strength in gausses. Field strength can be calculated quite readily under more nearly ideal conditions. However, in the present instance the polyphase submarine cables are heavily armored in metal and are, of course, completely submerged in a semi-conducting medium, so that actual conditions were far from ideal.

Experimental Tests—Equipment Design

In view of the above, it was decided to test the field available by a more practical and direct approach. An impregnated coil was arranged as in Fig. 3A. It was fixed in height and plane and connected to a suitable voltage amplifier with output indication. In this position (tide out) the intervening space consisted mostly of air and the output voltage was then noted. As the tide rose and eventually submerged the coil (as in Fig. 3B) the output voltage was again noted and found to have changed but very little. This was to be expected since both water and air are non-magnetic substances with permeability of unity. It was thus shown that the coil could be installed within the non-magnetic hull of the boat.

Approximation of Magnetic Field Intensity and Induced E.M.F.

The magnetic field around a long straight conductor which carries current may be considered as having an undistorted field of concentric circles. The magnetic field intensity H from such a conductor may be obtained from the expression,**

$$H = 0.2\,I/r$$

where

H = field intensity in lines of magnetic force per cm².
I = current in amperes
r = distance in cm. from the wire to point where the field is calculated.

For example, if we assume a long straight conductor shielded by non-magnetic material carries an alternating current of 35 amperes r.m.s. and if the surrounding medium has a permeance of unity, then the r.m.s. value of the field strength H at the

(** Permeability of sea water = Permeability of air = 1.0.)

surface with a cable depth of 15 feet (457 cm.) will be approximately

$$H = \frac{2I}{10r} = \frac{2 \times 35}{10 \times 457} = 0.015 \text{ line/cm}^2$$

In this instance, the extremes of water depth vary from a minimum of 12 feet to a maximum of about 50 feet. The extremes of H are about 0.019 line/cm² at 12 feet and 0.004 line/cm² at a depth of 50 feet. On the basis of these approximations which are no doubt considerably higher than the actual field, we may easily determine the induced voltage in the loops and, hence, therefrom the voltage ratio or decibels of voltage change from maximum to minimum water depth.

The r.m.s induced voltage is found from the fundamental expression of the alternating current generator and is

$$E_{rms} = 2\pi f n \phi/10^8$$
$$= 6.28 f n \phi/10^8$$

where

E = induced voltage, in volts,
f = frequency in cycles per second,
n = number of turns of the loop, and
ϕ = total lines of force contained in area of the loop and is equal to field intensity H times the loop area ($H \times \pi r^2$). This of course assumes that the size of the loop is small compared with the distance from the cable.

The loop designed consists of 1390 turns and has a radius of 12.7 cm. The mean area is $\pi r^2 = 3.14 \times 12.7^2 = 506$ square centimeters.

For a cable depth of 12 feet,

$$E_1 = (6.28 \times 180 \times 1390 \times (506 \times 0.019)/10^8$$
$$= (15.0 \times 10^6)/10^8$$
$$= 0.150 \text{ volt}$$

For a cable depth of 50 feet,

$$E_2 = (6.28 \times 180 \times 1390 \times (506 \times 0.0045)/10^8$$
$$= (358 \times 10^4)/10^8$$
$$= 0.035 \text{ volt}$$

The ratio of the voltages from minimum to maximum water depth in decibels may be expressed as 20 $\log_{10}$ (E_1/E_2), or

$$N_{db} = 20 \log_{10}\left(\frac{0.150}{0.035}\right)$$
$$= 20 \times 0.6434$$
$$= 12.8 \text{ decibels}$$

This appears to be in fair agreement with experimental results.

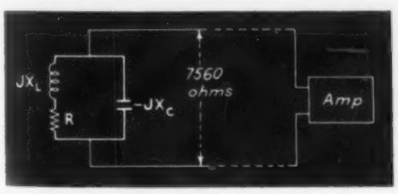
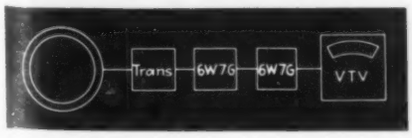
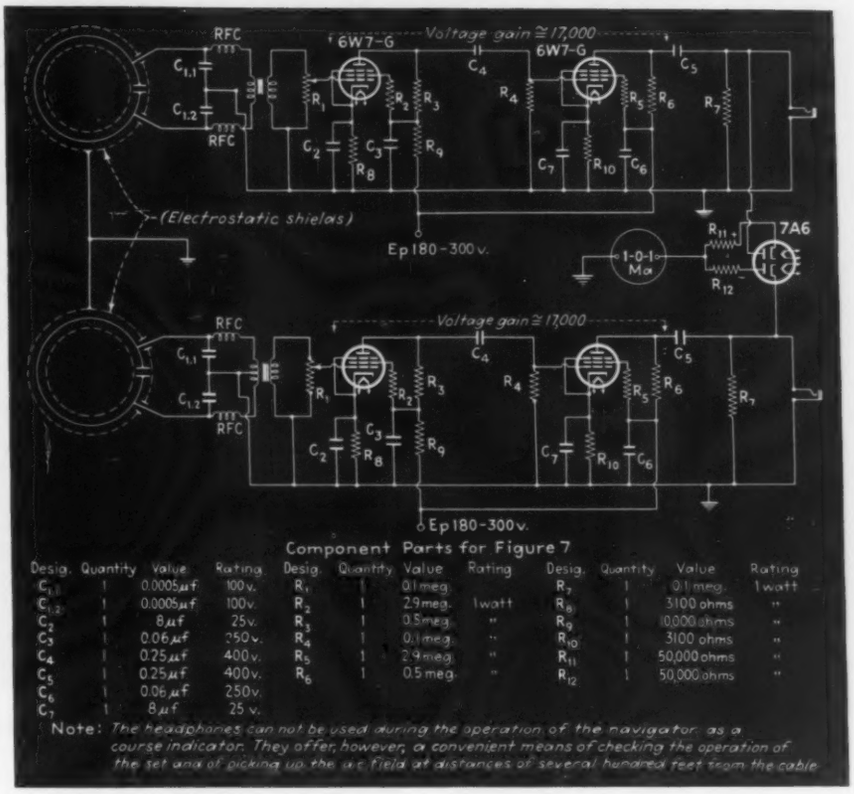


Fig. 5—Electrical constants of pickup loop

Fig. 6—Block diagram arrangement of elements of single loop flux navigator





Component Parts for Figure 7

Desig.	Quantity	Value	Rating	Desig.	Quantity	Value	Rating	Desig.	Quantity	Value	Rating
$C_{1.1}$	1	0.0005 μf	100 v.	R_1	1	0.1 meg.		R_7	1	0.1 meg.	1 watt
$C_{1.2}$	1	0.0005 μf	100 v.	R_2	1	2.9 meg.	1 watt	R_8	1	3100 ohms	"
C_2	1	8 μf	25 v.	R_3	1	0.5 meg.	"	R_9	1	10,000 ohms	"
C_3	1	0.06 μf	250 v.	R_4	1	0.1 meg.	"	R_{10}	1	3100 ohms	"
C_4	1	0.25 μf	400 v.	R_5	1	2.9 meg.	"	R_{11}	1	50,000 ohms	"
C_5	1	0.25 μf	400 v.	R_6	1	0.5 meg.	"	R_{12}	1	50,000 ohms	"
C_6	1	0.06 μf	250 v.								
C_7	1	8 μf	25 v.								

Note: The headphones can not be used during the operation of the navigator, as a course indicator. They offer, however, a convenient means of checking the operation of the set and of picking up the a.c. field at distances of several hundred feet from the cable.

Fig. 7—Schematic wiring diagram of double loop flux navigator circuit

Orientation of Loop

For practical reasons it has been found best to mount the pickup loop in one fixed position. This is in the vertical plane as shown in Fig. 4 and corresponds to the plane of maximum induction when the boat is traveling in the vertical cable plane. In this position, coupling with the ignition and electrical circuits of the boat's gasoline engine is at minimum and the signal-to-noise ratio is very high. Shielding or electrical suppression of the gasoline engine has been found unnecessary. Since, however, there can be but one position of the coil at any point in the magnetic field for maximum induced voltage (Fig. 4), it becomes evident that a fixed coil is at best a compromise in the interest of operating simplicity.

A loop which is suited for low frequency induction experiments† should have a large open field, as many turns as possible and a low power factor: i.e., high ratio of reactance to resistance. Flux densities are quite low and losses in the coil must be kept at a minimum. The problem is not unlike that for radio frequency circuits.

Experimental Loop Design

A loop circuit which has been found satisfactory is shown in Fig. 5. The coil is wound of No. 20 copper wire, has a diameter of 30.5 cm, a calculated inductance of 0.57 henry, a reactance of 644 ohms and a-c resistance of approximately 50 ohms. The power factor is 0.08, When shunted with 1.4 μf the circuit is resonant to 180 cycles.

The circuit is worked at resonance and, since jX_L and jX_C cancel, we may solve for the parallel impedance $Z = L/CR$ which gives an equivalent impedance around 8000 ohms.

An additional number of turns might have increased the voltage pickup but would also have increased the noise due to engine. The values of L and C used have been found to be satisfactory compromises.

(*Continued on page 178*)

† Morecroft, J. H., *Experimental Radio Engineering*, p. 21, 1931.

Simplified ELECTRON MICROSCOPY

Brief history of the development of the electron microscope leading to the introduction of the General Electric instrument with horizontal electron path; with electrostatic lenses; with simplified operation

By C. H. BACHMAN

Electronics Laboratory
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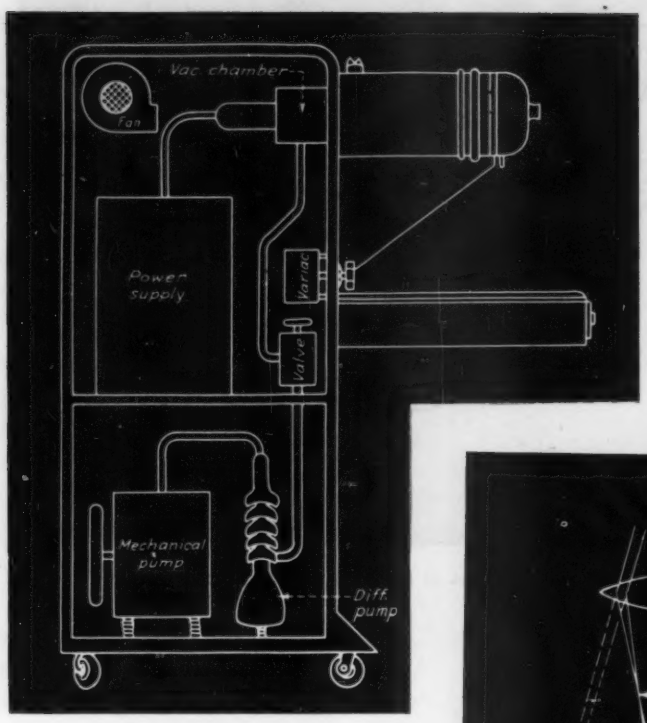


Arrangement of the microscope and its auxiliaries

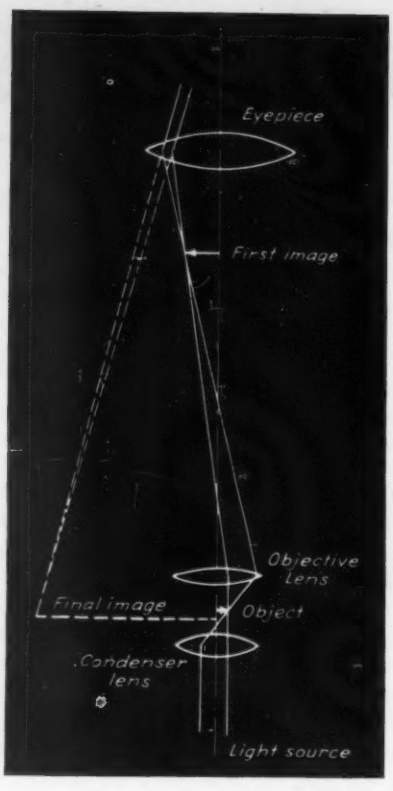


Diagram of ordinary optical microscope

THE history of any development usually can be broken up into periods or phases in which the activities of the development appear to have been directed toward some specific objective. The science of electron microscopy is just concluding the first phase of its history and is starting on the second. These past ten years or so have seen the birth of a new type of instrument and its development to the point where it has proven its worth to society. In this time it has graduated from the class of devices conceived, built and used in the laboratory by one individual, to the status of a commercial instrument available on the market and capable of being operated efficiently after a short training period for the operator.

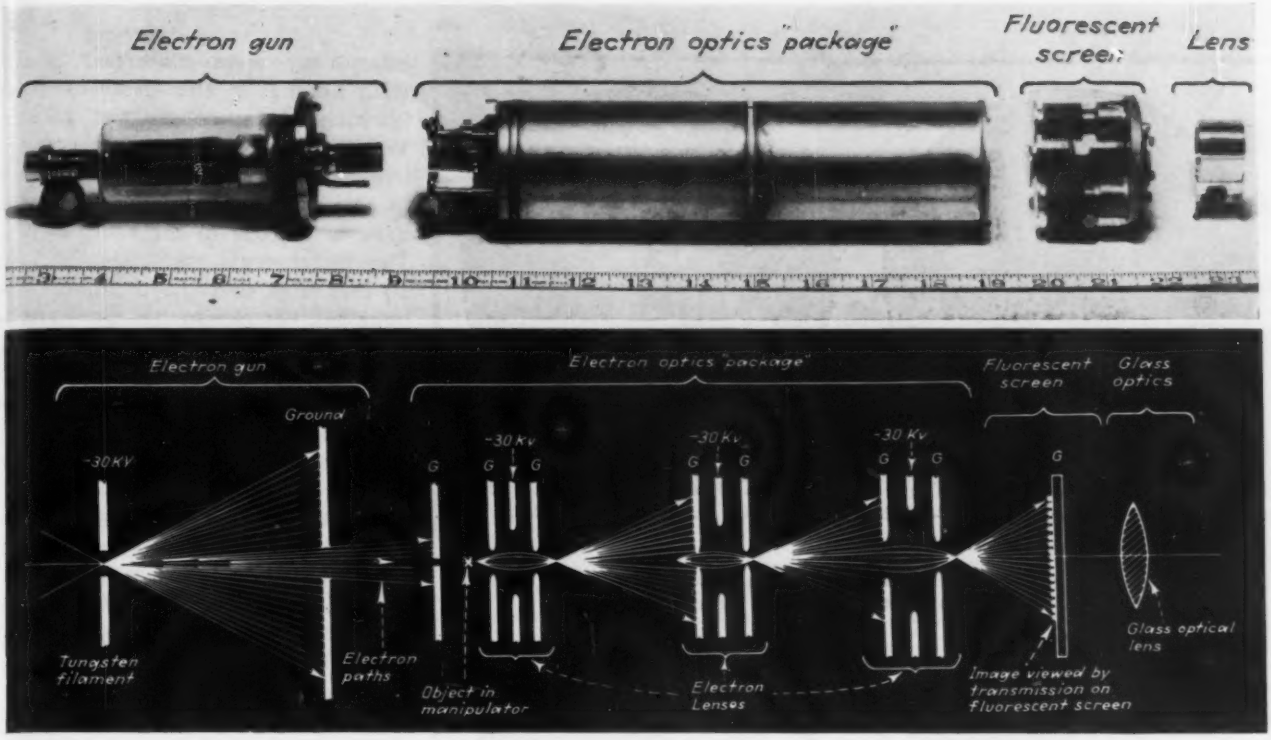
There is no doubt that the electron microscope has made a place for itself and is "here to stay." A permanent organization of electron microscopists was recently formed at a meeting in Chicago and there is every evidence that this infant science will grow rapidly. The next big step which is already well underway is the simplification of electron microscopy. Both the instruments and the techniques to date have had too much mystery and complexity inherent in them. The instruments must next be made available to and usable by the workers in the many branches of science who wish to use electron microscopes as tools to aid in their particular problems but who do not feel justified in taking excessive time to learn to operate and service complicated instruments.

In spite of the development to commercialization both in this country and abroad, most of the design fundamentals of the original instruments have been retained in principle. The purpose of this article is to describe an electron microscope which departs radically from the type of instrument which has nearly become traditional. This new microscope, although in use for some time in the General Electric Electronics Laboratory, was first publicly demonstrated in connection with the first Symposium on Electron Microscopy in Chicago in November, 1942.

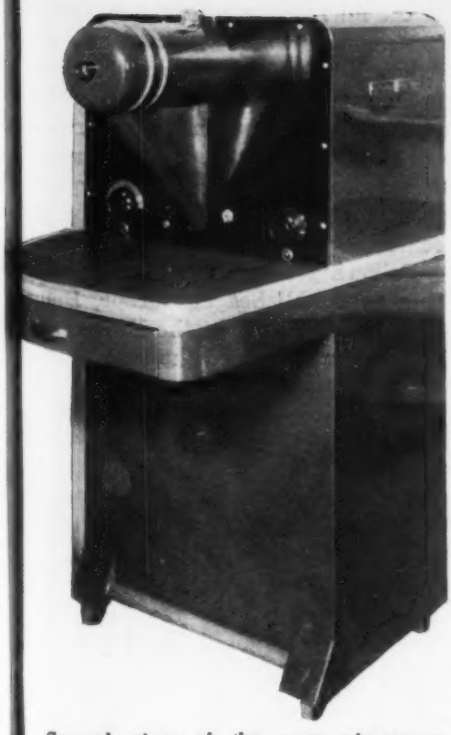
Before describing the instrument, it will be well to discuss briefly the functions which all microscopes must perform and to take up various alternative methods for carrying out these functions electronically.

Fundamentals of Microscopy

In the ordinary glass optical microscope using a transmission type object, a beam of light rays is caused to fall on the object or sample. In passing through the object, the rays are deflected, scattered and



Photograph and drawing above show the essential elements of the microscope



General view of the new microscope showing filament and high voltage controls at left. Eyepiece shown is removable for substitution of photographic plate-holder

absorbed in such a manner that the beam leaving the sample has taken on an identity characteristic of the object. This light beam is then gathered by the objective lens of the microscope and magnified in such a way that an image is formed in a plane suitable for further magnification and observation by the eye.

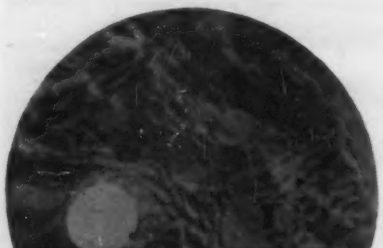
The average microscope of this kind is limited in magnification by a number of items including lens aberrations, illumination difficulties, suitability of object, and diffraction effects. Time has seen all these barriers subjected to concentrated attack and the best instruments combined with good technique have been able to achieve magnifications fairly close to the diffraction limit. This diffraction limit arises as a result of the physical size of the light waves. When the wavelength of light is small compared to the object we are viewing diffraction can be ignored, but as we attempt to view smaller and smaller objects, such that their physical size approaches the wavelength of the light used, the phenomenon of diffraction enters and we find distortion in the image. A physical explanation of the phenomenon is rather difficult although it can be treated thoroughly mathematically. Under these conditions, however, light is set in interference with itself to give rise to a phenomenon known as diffraction, and this is one of the limitations in obtaining accurate magnified images. Generally, the wavelength of light used limits useful optical magnifications to roughly 1000 diameters.

That electrons have associated with them a wavelength depending upon the potential with which they are accelerated was predicted about 20 years ago by de Broglie, and established a few years later by Davisson and Germer. That electric and magnetic fields can be arranged to react with electrons in ways analogous to the action of glass lenses on light rays was recognized and studied by Busch in 1926.

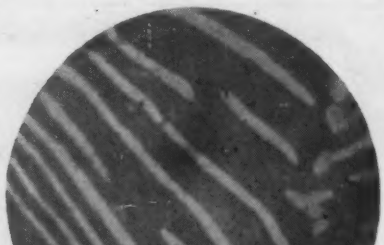
Since for commonly used voltages these electron wavelengths are very small compared to light wavelengths, it was natural that electron optics would be used as soon as possible to push back the limits to microscopy.

Early work consisted of emission studies[1] using tubes similar to ordinary cathode-ray tubes with some changes in electron gun and lens elements. The construction of an actual electron microscope for studying a variety of different samples in transmission presents an array of problems similar to those in ordinary microscopy. Instead of internal illumination, a source of accelerated electrons under control must be provided. If desired, the beam is condensed between source and object, although as in ordinary microscopy, this may not be necessary. An object stage or manipulator must be provided. The proper preparation of

[1] Examples of this early work may be seen on page 243 of ELECTRONICS, September 1933 —The Editor.

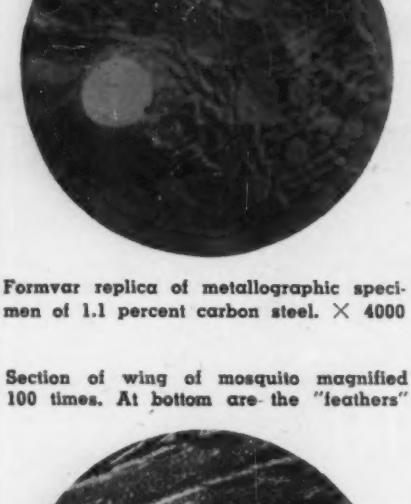


Formvar replica of metallographic specimen of 1.1 percent carbon steel. × 4000



Formvar replica of metallographic specimen of carbonyl iron. × 3000

Section of wing of mosquito magnified 100 times. At bottom are the "feathers"



Electron micrograph of "feather" of mosquito wing × 2500

the object, always a critical problem in the higher magnifications with an ordinary microscope, is even more critical with the still higher magnifications of the electron microscope and, in addition, the problem of "electron transparency" is encountered. In preparing the specimen its thickness, usually in the order of a tenth of a wavelength of light, must be balanced against the penetrating power of the electrons.

After the electron beam has traversed the object, taking on information just as did the light beam in the glass optical microscope, this electron beam must be accurately magnified to the desired degree and the final step consists of converting the information in the electron beam into something visible to the eye. This is usually done by fluorescent screens, or photography, or a combination of the two.

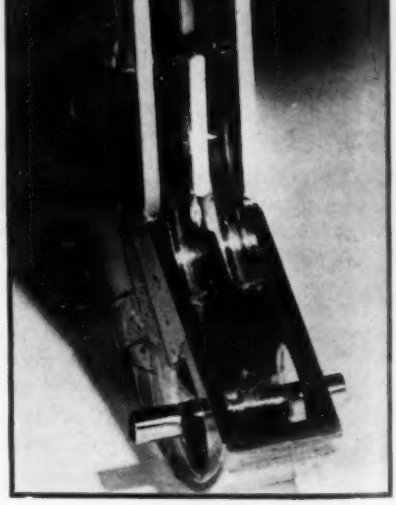
Although the electron-optical chain of events is similar to the optical chain in the ordinary microscope, further complications must be considered. For instance, a pre-requisite to the use of electrons is a good vacuum. This means that the specimen must be inserted into and removed from the vacuum chamber. Any motion of the specimen or of any of the microscope parts must be done by remote control. A complete vacuum pumping system is thus part of the instrument. Although electrons having very low velocities (a few volts) have a satisfactorily short wavelength, it has been found desirable to use voltages of from 15 kv to 100 kv to obtain satisfactory penetrating power and brightness of the fluorescent screen; to date, most microscope workers have found 40 kv to 60 kv to be most useful. In addition to the elemental microscope structure, the complete microscope has a vacuum pumping system and its attendant restrictions, and a high-voltage power supply with the problems that go with it.

Development of Practical Microscopes

The first workers in electron microscopy were concerned mostly with arranging the electron optics in such a way as to get results. Weight, compactness, and convenience probably were not considered to any extent. This first work was done in Europe in the early 1930's. The instruments were usually 7 to 10 feet high and the pumping systems and power supplies were auxiliary equipment usually segregated from the microscope proper. The optical axis was vertical, the electron gun being at the top and the fluorescent viewing screen at the bottom. In the early models, the whole microscope tube had to be opened to air to place specimens in the stage or to insert photographic plates in the path of the beam, this being the method of photography used. Preliminary insertion chambers were soon added, however, for both specimen and photographic plate insertion. By means of these modifications the object to be placed in the microscope is first inserted in the chamber which is closed and exhausted. An inner gate is then opened and the object moved into position—all by remote control—without affecting the main vacuum. These preliminary chambers require additional pumping capacity, of course.

Following the same general structure as established in Europe, Hall, Prebus and Hillier at the University of Toronto completed the first North

Cutaway view of the electrostatic unipotential electron lens



American instruments in the years 1935 to 1940.

Shortly thereafter, RCA made available the first commercial adaptation in this country while A.E.G. introduced a model in 1940.

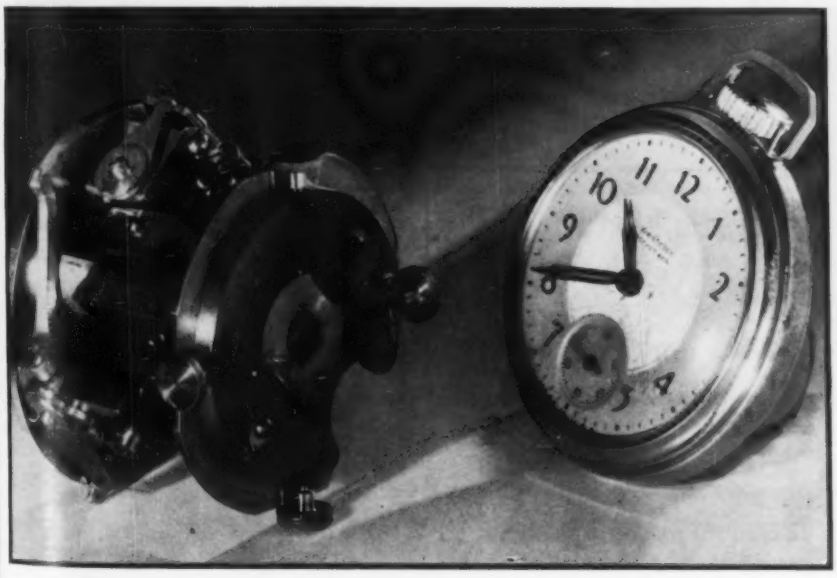
Inasmuch as electron microscopy seemed an assured science, it seemed advisable to look at the whole subject with the purpose of breaking from the traditional vertical type with all the associated complications and size which had hitherto been taken for granted in the gradual development. It quickly became apparent that the microscope should not be considered as a unit with external accessories but that the pumps, power supply and vacuum chamber should be treated as a group in which any change in one part might make a radical change in some other.

Essential electron-optical parts of the G-E instrument

In considering the possible variation of elements of the microscope, they were examined with an eye to simplicity and convenience in operation and maintenance. At the same time, refinements leading to improved image quality had to be balanced against simplicity of manufacture; the economic factor is quite important in making available to the largest possible group of workers the best possible extension in magnification over ordinary optical microscopes.

A survey of much of the electron microscope work being carried on revealed that most of it fell within the range of ten times the power of the glass power of the glass-optical instruments. True, many pictures were being taken with much better resolution than this, but it seemed that there was ample justification for an instrument of such range if it could really be simplified and made more universally available. As a result of these considerations construction of the G-E simplified electron microscope was undertaken. To achieve the goal of ten times the power of the light microscope, a resolution of at least 200 Angstrom units was specified. It was possible to attain this and still relax many of the closer tolerances in the interest of simplicity and economy.

Details of specimen holder showing lever actuated by tierods to eyepiece end of instrument. Pocket watch gives idea of size of the specimen holder



Choice of Electrostatic or Electromagnetic Lenses

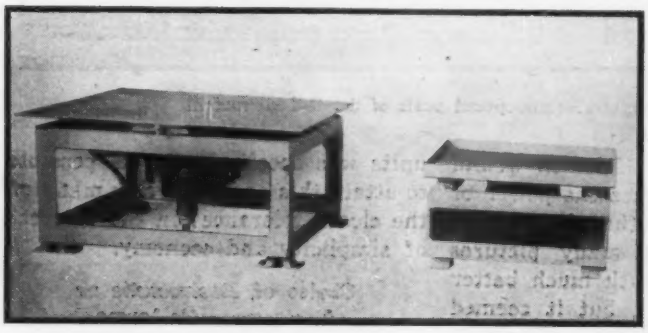
The first major choice that had to be made concerned the type of lenses to be used. Electromagnetic lenses had been chosen by all microscope builders except A.E.G., in Germany, which reported work on both methods and that the electrostatic approach was promising. This was in line with the experimental and theoretical experience of the General Electric Company up to that time. Now each of these electron optical approaches has its own list of requirements and peculiarities; a feature that may be an advantage in one application is sometimes a disadvantage in another.

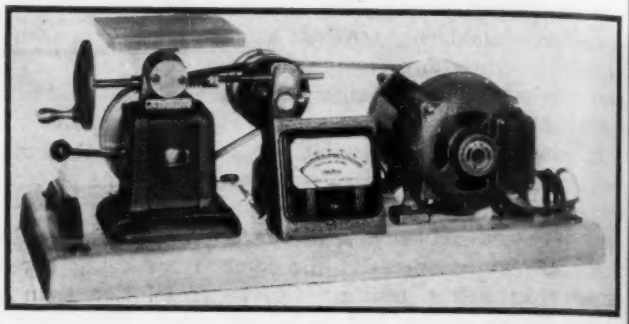
An electromagnetic lens usually consists of a coil of wire surrounding the microscope axis and including pole pieces so shaped as to give concentrated flux gaps having the desired field distribution. Since the coil is usually outside the vacuum chamber, physical manipulation for purposes of centering is fairly convenient. The lens is activated by current flowing in the coil and since this is a low voltage application there is no insulation problem associated with the lens. Variations in the focal properties of the lens are easily accomplished by varying the

(*Continued on page* 195)

VIBRATION
HUMIDITY
TEMPERATURE
PRESSURE

TEST





VIBRATORS

Vibratory packers such as these electro-magnetic devices built by Syntron may be pressed into service for testing parts and even complete electronic assemblies. Amplitude is readily rheostat-controlled so a reasonable degree of flexibility is obtainable

This motor driven fatigue tester made by All American Tool produces vibration by simple harmonic motion. Displacement is adjustable up to ¼ inch and frequency, variable between 10 and 60 cps, is indicated by an electric tachometer

COMPONENT PARTS used in much of today's electronic equipment must be subjected to simulated severe field conditions during design if they are to render satisfactory service. It is necessary, for example, to determine precisely how much vibration, gravitational pull or mechanical shock relays will stand and still function. The effect of humidity near the saturation point upon the insulation of transformers and the extent to which corrosive atmospheres deteriorate finishes is important. Variation in the characteristics of controls, resistors and capacitors at temperature extremes has to be known. Switches and other parts incorporating air gaps need to be tested for breakdown at low pressures.

Vibration, humidity, temperature and pressure test generators and chambers are thus coming into universal use in electronic equipment plant laboratories. They are also finding widespread application as production tools. Component part samples may be checked for noisy connections or contacts by placing them in the input circuits of high gain amplifiers and shaking them violently as they leave the assembly line. Several parts out of every new run may be soaked or sprayed in machines which deliver humid weather at an accelerated rate to insure uniformity of insulation and finish. Certain components may be pre-aged by cycling them between temperature extremes, close mechanical fits may be obtained by contracting inserts in refrigerators before assembly and it is not unusual to find manufacturers repeating adjustments during cyclic runs to insure permanence of assembly and calibration. Arcing between parts at low pressures may, similarly, be checked in chambers originally purchased for design work.

Typical PARTS Test

SHAKE . . . 15 G's

SOAK . . . salt-spray

FREEZE . . minus 70 deg. F

ROAST . . . plus 200 deg. F

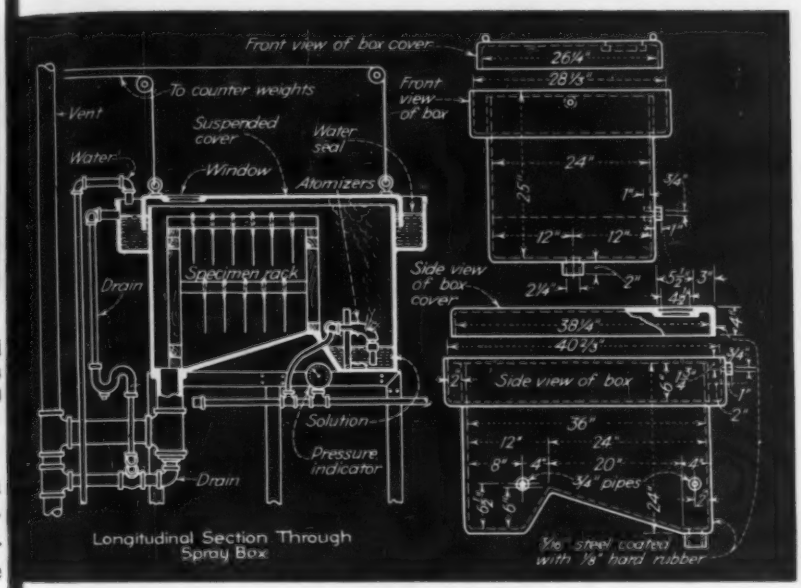
DECOMPRESS . . 50,000 ft.

There are, undoubtedly, other methods of utilizing devices of the type under discussion as production aids as well as additional design laboratory applications. These must be left to the ingenuity of individual engineers. It is the purpose of this text to present an overall picture of commercially available equipment. This is done by discussing the features of recently introduced test apparatus and by including additional details concerning machines described since the spring of 1942 in the New Product Department of ELECTRONICS. Still other machines will be described

By W. W. MacDONALD
Associate Editor

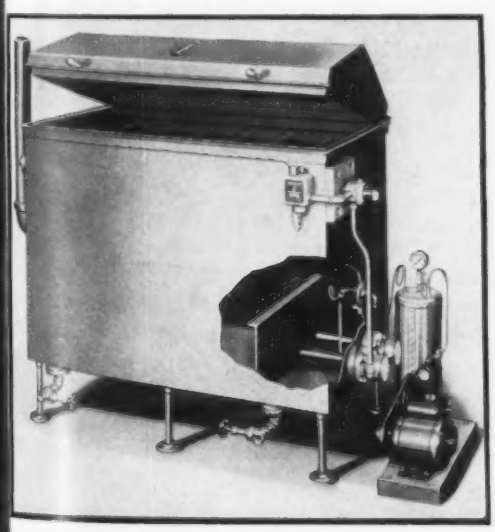
Generators and Chambers

Component parts used in much of today's electronic equipment must be subjected to simulated severe field conditions during design and production if they are to render satisfactory service. Typical machines with which such work is done are described



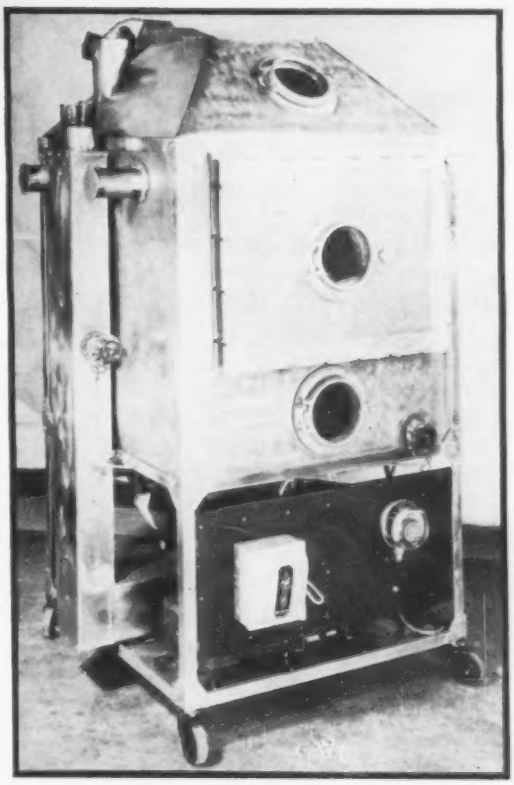
SALT-SPRAY TESTERS

One of several salt-spray apparatus designs suggested by the Bureau of Standards for rapidly determining the resistance of metals and other materials to corrosion. Complete units meeting current requirements and embodying refinements are now commercially available



LEFT. . .Corrosion tester manufactured by Industrial Filter & Pump. It supplies the requisite saline spray and is equipped with immersion heaters which permit the solution temperature to be adjusted between 65 and 140 deg. F

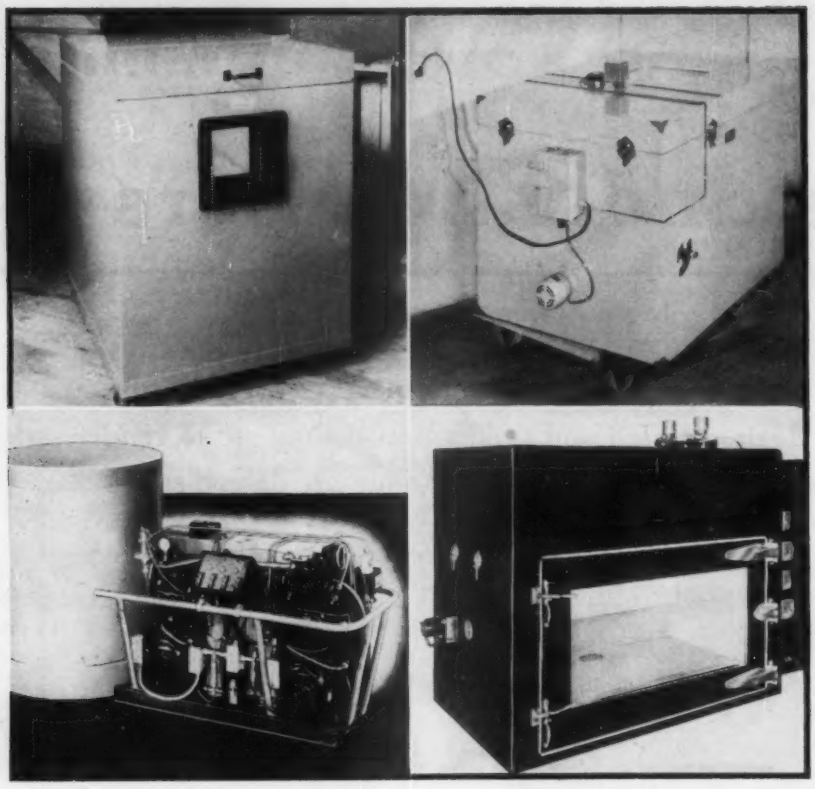
RIGHT . . . Apparatus built by American Instrument floods samples with a fine sodium chloride saturated mist, permits hot air to be applied during the test and also includes ultraviolet lamps further accelerating any tendency to corrode



in the columns of this same department in coming months, as data concerning them is obtained.

Vibration Generators

Impact testers, devices dropping a padded hammer an adjustable distance onto the component part, or dropping the part itself an adjustable distance onto a pad, have been used for some time to determine the ability of equipment to withstand mechanical shock. Most of these have been built by plant engineers to fit their specific needs and many con-



TEMPERATURE CHAMBERS

TOP LEFT . . . Chest built by Revco, one of several models which provide temperatures between ambient and minus 50 deg. F or lower. The top is double hinged, for partial or complete opening during tests

BOTTOM LEFT . . . An industrial unit designed by Deepfreeze, suitable for test temperatures from zero to minus 50 deg. F. By cascading such units temperatures as low as minus 120 deg. F may be obtained

TOP RIGHT . . . This cabinet, made by American Instrument, maintains temperatures between zero and minus 90 deg. F. Another model, equipped with electric heating units, has a range from minus 90 to plus 200 deg. F. Both models employ dry ice

BOTTOM RIGHT . . . Chamber made by American Coils. Range is from minus 67 to plus 160 deg. F. A positive system of circulating air is included in the design

tinue to be used where this type of test is specified by ultimate component parts users. Vibration tests have, however, been substituted in many instances, acceleration and reversal of direction of movement producing a pull many times that of gravity which shows up certain defects with greater facility.

Vibratory packers of the type made by Syntron, primarily for shaking down small manufactured items so that they occupy a minimum of space in shipping cartons, have been widely used by electronic equipment makers to test finished assemblies weighing up to 750 lbs. for faulty connections and loose components. Now such packers are being pressed into service to determine the vibration resistance of component parts themselves. Consisting of spring-insulated metal plates up to 30 by 30 inches in area, driven by a-c operated electro-magnets, these particular machines have a degree of flexibility suitable for some tests as the amplitude of vibration is readily controlled by inserting a rheostat in series with the supply line. By measuring the amplitude of platform movement and applying this figure to the more or less fixed frequency at which the plates vibrate the pull which tested parts withstand may be determined within fairly wide limits.

Where relatively small parts must be tested over an extremely wide range and very accurate performance data is needed, machines such as one built by All American Tool specifically for this purpose are commonly used. A ½-hp, 60-cycle, split-phase 110-v a-c motor drives a 6 by 6 inch test table through a system of eccentric pulleys and belts. Parts weighing up to 10 lbs can be bolted to the table, which incorporates drilled holes facilitating mounting of the work. Accessory plates which may be bolted to the table permit angular tests to be run. Simple harmonic motion is generated and frequency, indicated by an electric tachometer, is continuously variable between 10 and 60 cps while the machine is in operation. Displacement or excursion, adjusted with the machine at rest, is variable up to ¼ inch. Maximum testing capacity is 28 g's, or 28 times gravity.

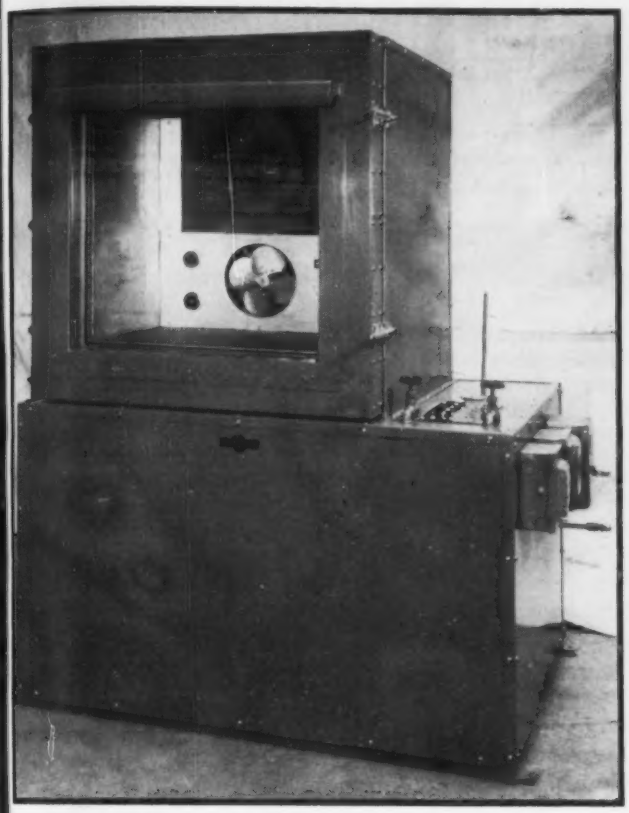
A similarly specialized vibration tester designed by Kurman Electric but not at present commercially available shakes 5-lb parts up as high as 30 g's, which is equivalent to imparting an accelerating force of 150 lbs, and does it without transmitting appreciable vibration to the table or bench on which it stands. The part to be tested is bolted to the upper tine of a vibratory fork, out-of-phase movement of the lower tine providing inherent balance. Frequency, variable between 20 and 60 cps, is adjusted by means of a reversible motor which drives a threaded shaft and moves a shorting bar determining the length of the fork arms. A reed tachometer indicates operating frequency. The fork is driven electro-magnetically by a set of coils which are mounted integrally with the shorting bar. Driving power is d.c., which may be obtained from various kinds of external power supply units, and is applied to the coils through an adjustable set of interrupter contacts and a slider rheostat. Amplitude, variable up to ½ inch, is adjusted by moving the slider rheostat and is directly indicated in ⅛ inch or half-millimeter steps by a calibration wedge engraved on the end of the upper tine. Applied accelerating force is shown graphically as a function of frequency and amplitude on a chart supplied with the device.

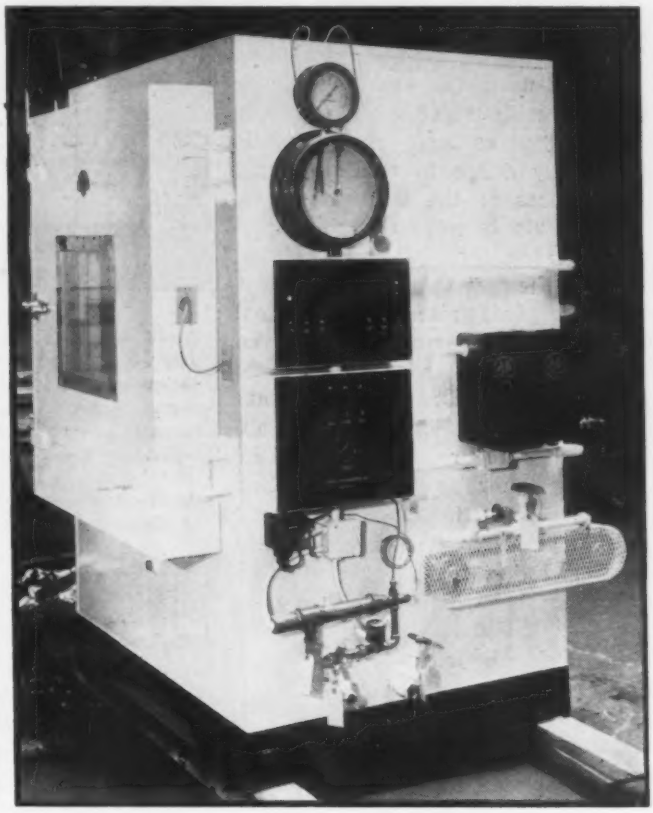
Until quite recently relatively few

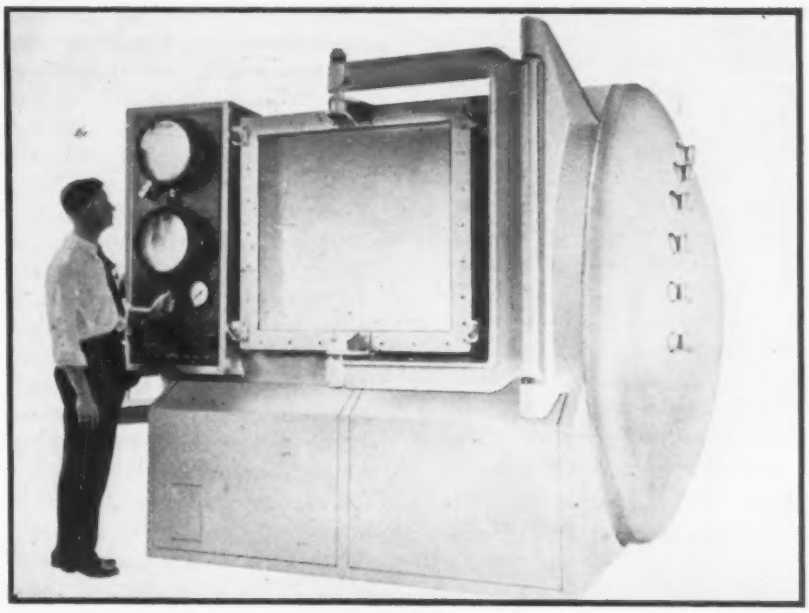
manufacturers of electronic equipment have owned salt-spray test apparatus suitable for rapidly determining the ability of materials and finishes to resist corrosion. Pre-war machines were almost invariably constructed by engineers in plants with a particular need for them and examples seen in the field appear to be modelled closely around suggestions contained in the National Bureau of Standards' letter circular number 530.

Salt-Spray Corrosion Testers

Current test requirements are in some respects more severe than they were at the time the Bureau released its circular but, in the main, ideal test conditions visualized then constitute a good guide. These called for exposure of specimens to a dense mist or fog of unchanging composition, such as 20 parts by weight of sodium chloride and 80 parts of distilled water, at a constant temperature of 95 deg. F, for 100 hours. The spray or mist produced by several machines described in the circular was invariably formed by an atomizer or nozzle, usually consisting of two nipples placed at right angles







TEMPERATURE AND PRESSURE CHAMBERS

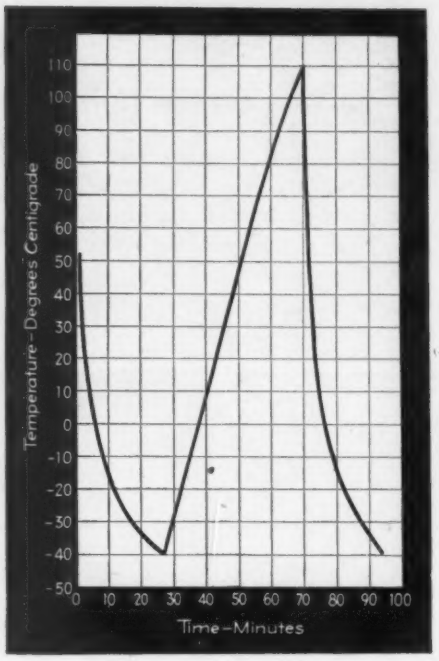
ABOVE . . . One of two units designed by Mobile Refrigeration. Temperature range is from minus 40, 76 or 100 to plus 158 deg. F, depending upon specified requirements. Pressure may be adjusted between that encountered at an altitude of 50,000 ft. and 30 lbs per sq. in. and various degrees of humidity are provided

RIGHT . . . Equipment built by Kold-Hold operates between minus 75 and plus 200 deg. F, with pressures ranging from that at the location of the unit to 3 inches of mercury. Humidity may be controlled over a wide range

ABOVE RIGHT . . . One of several chambers made by Tenney Engineering. It provides test temperatures between minus 40 and plus 150 deg. F. Range can be widened, narrowed or shifted to meet special requirements. Available pressures range from atmospheric to the equivalent of 50,000 ft. or more. Virtually complete control of humidity is provided

to each other. Compressed air, saturated with moisture, when sent through the horizontal nipple in such a device, tends to create a vacuum which draws solution to the top of the vertical nipple, where it is atomized. The atomizers employed were either made of glass and operated at a relatively low pressure of from 10 to 15 lbs per square inch or were made of hard rubber or monel metal and operated at a relatively high pressure of from 25 to 50 lbs per square inch. Cabinet sizes varied from 5 to 1,000 cubic feet, depending upon the nature of the work to be handled, cabinet size being relatively unimportant so long as the fog is sufficiently dense to wet uniformly all surfaces of the test specimens. Large cabinets were equipped with several atomizers. It was pointed out that the fact that air pressure is involved gives rise to directional effects. To prevent spray from impinging upon specimens baffle plates were recommended. Vents were similarly specified, preferably conducted outdoors, and designed in such a manner as to hold cabinet pressure constant.

Details of one particular salt-spray box designed by the Bureau are shown here in a simplified line drawing. It is constructed of $\frac{1}{8}$ inch steel, with all joints welded, and coated both inside and out with $\frac{1}{8}$ inch of hard rubber. The box, it will be noted, is maintained in a horizontal position and a dam and drainage system provided by a "V" bottom. The sump in the front is of sufficient size to allow the atomizers to be directed away from the specimens and against the front of the box, which thereby serves as a baffle plate. An inverted bottle containing reserve solution is supported over the well in the box to maintain a constant solution level. The vent is located in the bottom, toward the rear of the box and also serves as a drain for spent solution as it is connected to an exhaust stack as well as to the sewage system. The tendency is for the spray to pass over and down the specimens, producing a uniform attack. Two low pressure atomizers are used and a novel feature is the elimination of cover leakage, encountered in some earlier models, by the use of a water seal. A small glass window is incorporated in the cover,



Speed with which test chamber conditions may be changed is important when both design and production must keep in high gear. Illustrated is the time-temperature curve of one efficient unit. Speed is also important where certain field conditions must be closely simulated. Another test chamber evacuates air to the pressure equivalent of 50,000 ft. in 7½ minutes

sealed with asphalt-asbestos roofing compound, permitting observation of the density of the fog at that point. Designed primarily for use in the Bureau's own laboratories, this box does not incorporate temperature control as it was built to be used in a room having satisfactorily constant temperature.

Complete salt spray corrosion test units embodying flexibility necessary to meet widely varied specifications and refinements which make them easy and economical to operate have recently been introduced commercially by several firms. Industrial Filter & Pump, for example, makes four such devices, ranging in size from 24 in. long, by 15 in. wide, by 30 in. deep to 48 in. long, by 26 in. wide, by 36 in. deep. The salt water compartment, with atomizer and spray baffle, occupies an area 10 in. long and 18 in. high across the width at one end of the bottom inside each cabinet, leaving the remaining space for racking long test pieces the full length of the upper part, smaller items to be tested being accommodated in the lower part of the chamber. Atomizers incorporated within these machines consist of glass tubes supported by hard rubber holders. Tips are adjustable to obtain desired spray densities and when received from the factory are pre-set for operation at 25 lbs pressure. A conventional gauge indicates operating pressure. A nickel shield or baffle plate is provided. Consumption of salt water, supplied from built-in 7- to 11-gallon tanks, will normally be between 3 and 4 gallons per 24 hours. The compressor, suitable for constant duty, is driven by a $\frac{1}{3}$-hp motor. The entire testing cabinet is lined with $\frac{1}{8}$-inch thick cured vulcanized rubber. Angle rests and removable cross pieces from which work may be suspended or on which it may be supported are rubber covered. A groove 1 inch wide and $\frac{1}{2}$ inch deep around the top of the cabinet, when filled with water, provides a leakproof seal. A 1,000-watt immersion heater suitable for operation on single-phase current is included close to the bottom of the salt water compartment and permits solution temperatures to be adjusted

TIGHTLY B

a temperature control bulb in combination with a thermostat automatically maintains temperatures within plus or minus 2 degrees. The salt-water compartment is provided with a drain valve and another valve allows drainage of spent salt water accumulated within the test compartment.

Ultraviolet Tester

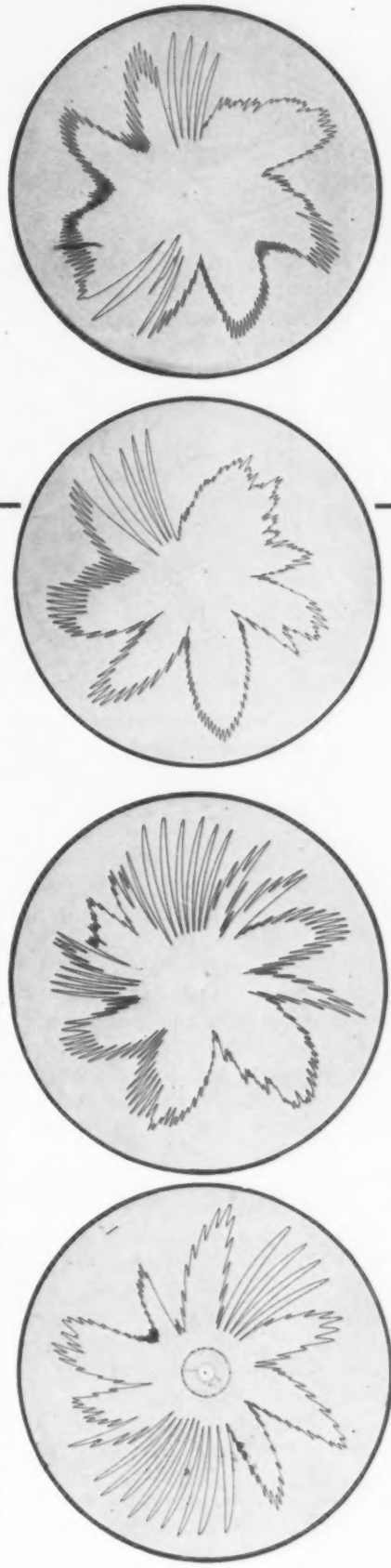
Another typical commercially available salt spray corrosion tester, designed by American Instrument, provides means for flooding samples with a fine mist, incorporates equipment which supplies hot air to the samples and so permits temperature control. A novel feature is the inclusion of ultraviolet lamps with which any tendency of work to corrode may be further accelerated. An electrical system controls automatically the temperature of air striking samples and the temperature of the salt solution. Another automatic

(*Continued on page* 203)

An Electronic CURVE TRACER

By PHILIP PADVA
Los Angeles, Calif.

Electronic instrument forces a spot of light to follow a curve to simplify the job of the control engineer



Typical graphs circular in form which the device described can "see" and track

THE charts appearing here are utilized by many organizations to record the flow of such commodities as gas, oil, water, electricity, steam, etc. to form a permanent record of the instantaneous flow. Subsequently, the chart is removed from the recording meter and integrated to get a summation of the

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Many conditions are recorded in graphic form which require integration and do not embrace the relationship of producer and consumer. For example a thermoelectric generator placed within a gasoline engine cylinder will, through suitable means, record upon a chart the curve or graph of the heat developed during its firing cycle; and it may be desired to obtain a summation of the heat thus expended. The integration in this instance would require accuracy for its own sake, for the more precise knowledge obtained.

This article will present a method based upon electronic principles which eliminates the human factor entirely, thus enabling different operators to obtain the same integrated answer regardless of the complexity of the graph or of the duration of the time interval between readings.

The diagram shows the essential arrangement of components necessary to obtain the suggested results. Light originating at L is passed through a pinhole and chopped at this point. The light continues through a converging lens system and impinges upon the reflecting mirror M_1 which is mounted upon a pivoting shaft. The light is directed to an inclined and curved reflecting mirror M_2 which deflects it to the under surface of a translucent chart. The light at this surface has reached its focal point and becomes a "spot" approximately 0.005 inch in diameter. The light contained within the spot undergoes much diffusion as it exits through the upper surface of the chart.

At this point, a phototube would be required with a cathode long enough to accept the full arc resulting from the movement of the pivoting mirror M_1, and provision would have to be made to compensate any variation of sensitivity of the cathode surface throughout its entire length. The method we have chosen to employ embodies the use of a phototube of conventional size placed within the light chamber C.

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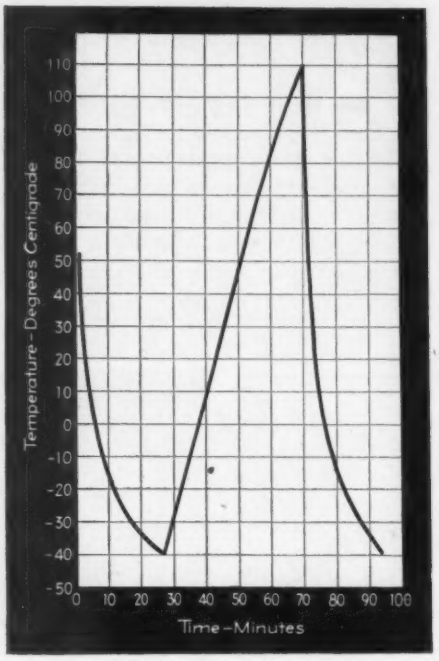

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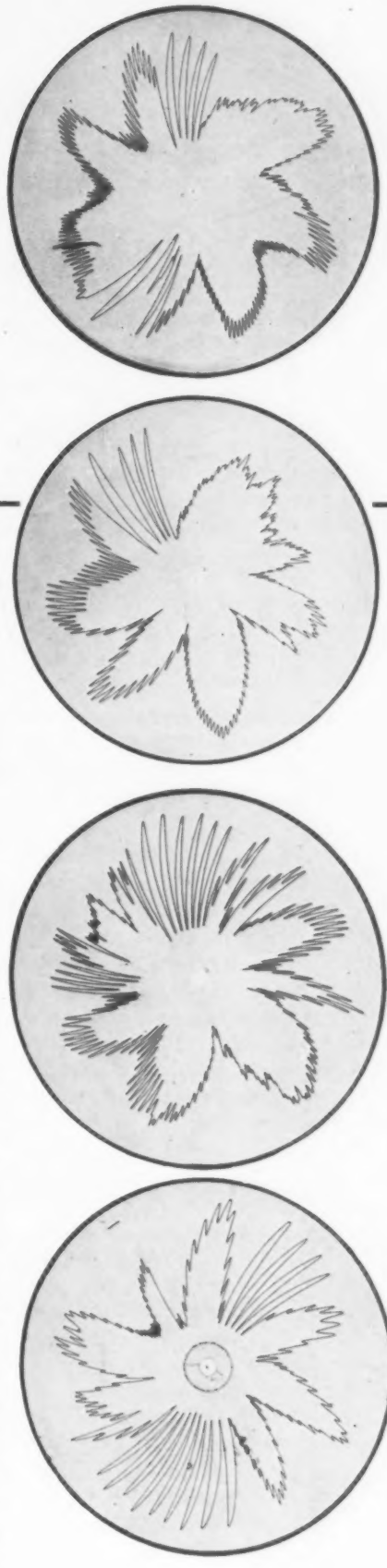

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The method of integration most generally employed is manual. A planimeter is used, and its stylus is guided by hand over the contour of the graph. This method is obviously slow, and the error increases as the irregularity of the graph is increased. Indeed, two operators will seldom obtain results which are in agreement, particularly when a complex graph is involved, and further, the same operator will find difficulty in obtaining the same answer twice. This situation creates accounting difficulty between the producer and consumer enterprises, for most generally, it seems the producer reads the graph high in value, and the consumer reads it low.

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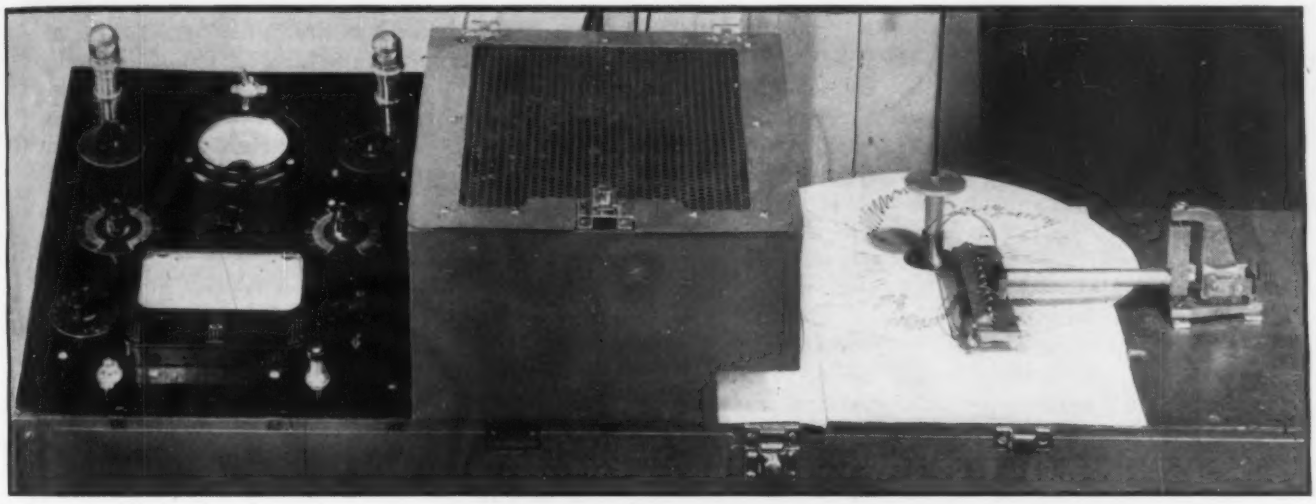
At this point, a phototube would be required with a cathode long enough to accept the full arc resulting from the movement of the pivoting mirror M_1, and provision would have to be made to compensate any variation of sensitivity of the cathode surface throughout its entire length. The method we have chosen to employ embodies the use of a phototube of conventional size placed within the light chamber C.

paper upon the spot can be made comparatively large or small by modifying circuit constants. Indeed, it can be made vanishingly small if desired. The maximum movement of opaque paper into the spot should not be greater than the diameter of the spot if normal operation is to be obtained. That is, a movement of 0.005 inch will reveal the spot entirely, or totally obscure it. Since it is unnecessary to modify more than a small part of the total light resident in the spot to cause it to move through its full arc, the amount of actual obscuring or revealing of the spot by the opaque paper is a small part of the total spot diameter of 0.005 inch. This value, as has already been stated, can be modified by circuit constants so that for practical purposes, the relationship of spot to the edge of the opaque paper is virtually constant.

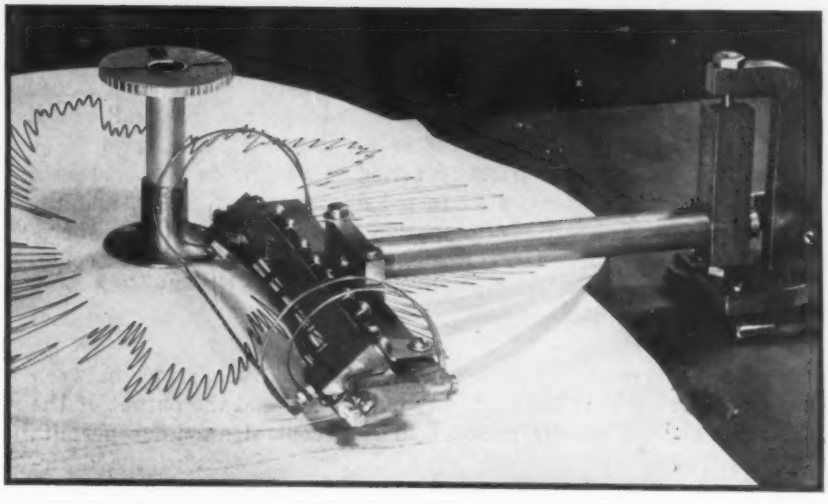
The opaque paper used previously to obscure the spot can be replaced by a graph penned upon a chart. The spot is placed in contact with the graph (the line upon the chart) and the chart caused to rotate. Should the curvature of the graph at this point be such that its amplitude is increasing (assuming that the zero reference point is toward the center of the chart), then it will tend to intrude upon the spot, the light is reduced and consequently, the spot will retreat before it. When the spot reaches that point of the graph wherein its amplitude is decreasing, the graph will, in effect, fall away from the spot, the light output is increased, and the spot will tend to maintain contact with the graph by virtue of the increased output of the amplifier. This action is, of course, not as discontinuous as description demands, but is, on the contrary, smooth and without interruption, so much so, that the charts which are approximately 11 inches in diameter, of a complexity readily discernible on page 87, are "seen" and "tracked" at an arbitrary standard rate of 60 seconds for a complete revolution, although this instrument can be operated at twice the speed, that is, in 30 seconds. This rate could be stepped up to an enormous degree.

If the spot were adjusted to be merely in contact with the graph, it could be obscured, but it would not be further revealed or exposed. Therefore, when the relationship of degree of contact between the spot and the graph is adjusted for normal tracking conditions, the spot of 0.005 inch diameter is permitted to be half obscured by the graph. Thus, the motion of the graph, as the chart rotates, can cause an increase or decrease of spot area as the graph falls away from or intrudes upon it.

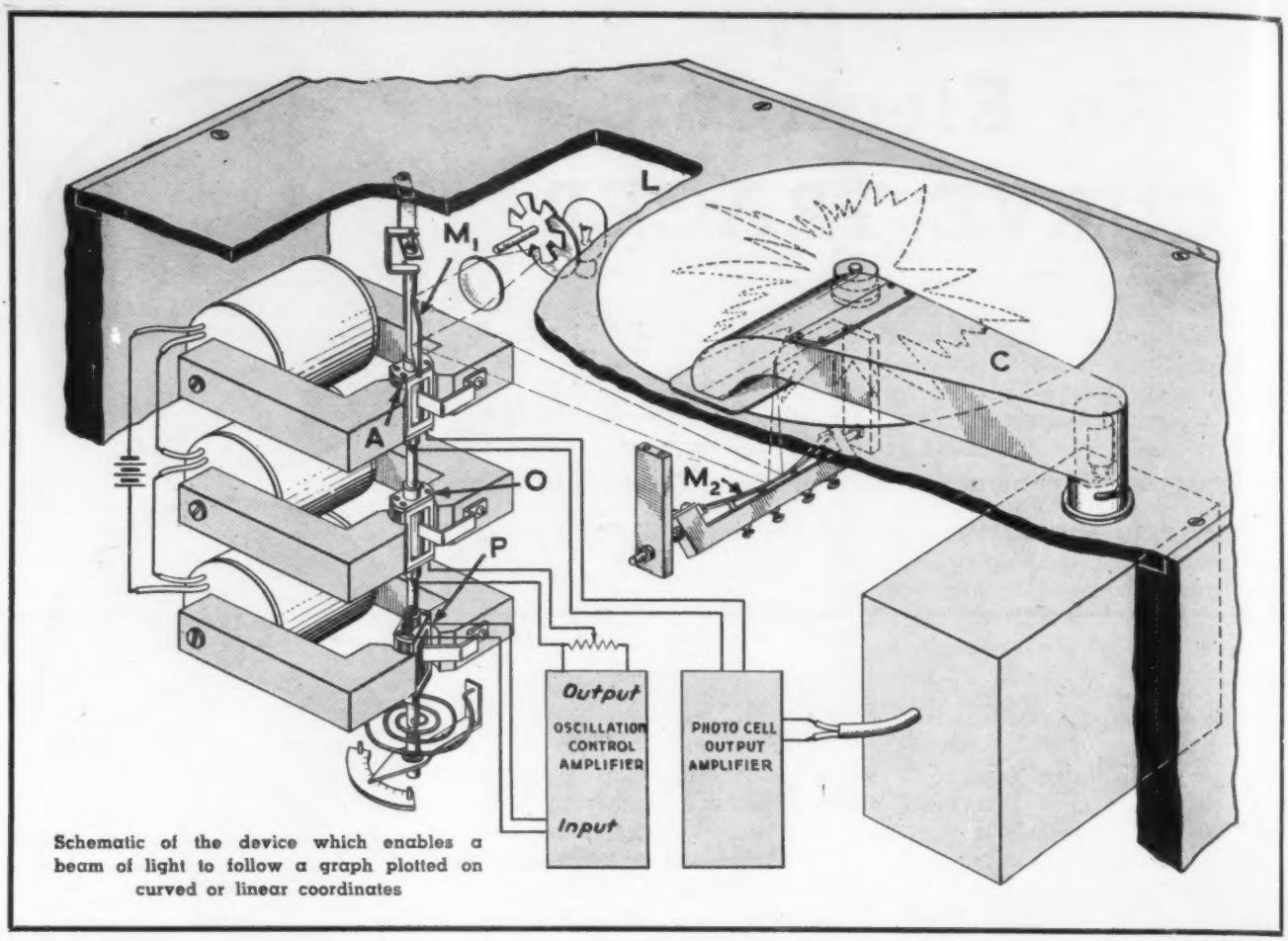
It is not desirable for the spot to be too small because the grain of paper upon which the graph is imprinted will have a disturbing effect. The use of a material other than paper for the printing of the graph would permit use of a smaller spot.



Overall photograph of the instrument in operation, together with the curve in position under the "seeing" end of the mechanism



Closeup of the scanning end of the instrument. On the cover of this issue the spot of light may be seen as it is made to follow the curve. The dimensions of the spot have been increased so that it could be seen after making the engraving and printing it



Schematic of the device which enables a beam of light to follow a graph plotted on curved or linear coordinates

The diffusion caused by the passage of light through the translucent chart, plus additional diffusing screens placed at judicious locations, produces a high degree of uniformity of response as the "spot" travels from extreme to extreme of its arc of movement.

The mirror M_2 requires curvature to cause it to conform to the curved radius produced upon the chart by a *pivoting* recording pen. This mirror could, of course, be straight, or of some other shape to permit duplication of the path of the recording pen.

The light now continues on to the phototube which utilizes a preamplifier to boost the signal to a relatively high level. The preamplifier passes its output into the "photocell output amplifier", wherein the signal is rectified and turned into a coil A mounted on the same shaft as M_1.

The relationship between the polarity of magnetic field produced by the current in this coil, and the external field in which the coil is immersed is such that the coil and the mirror M_1 attached to it urge the spot toward the center of the chart.

A spring provides bias or tension in the opposite direction, toward the periphery of the chart, and it is so adjusted that its pull will be somewhat lower than the tug of the coil; so that the spot, when not obscured, will travel or pull toward the center of the chart.

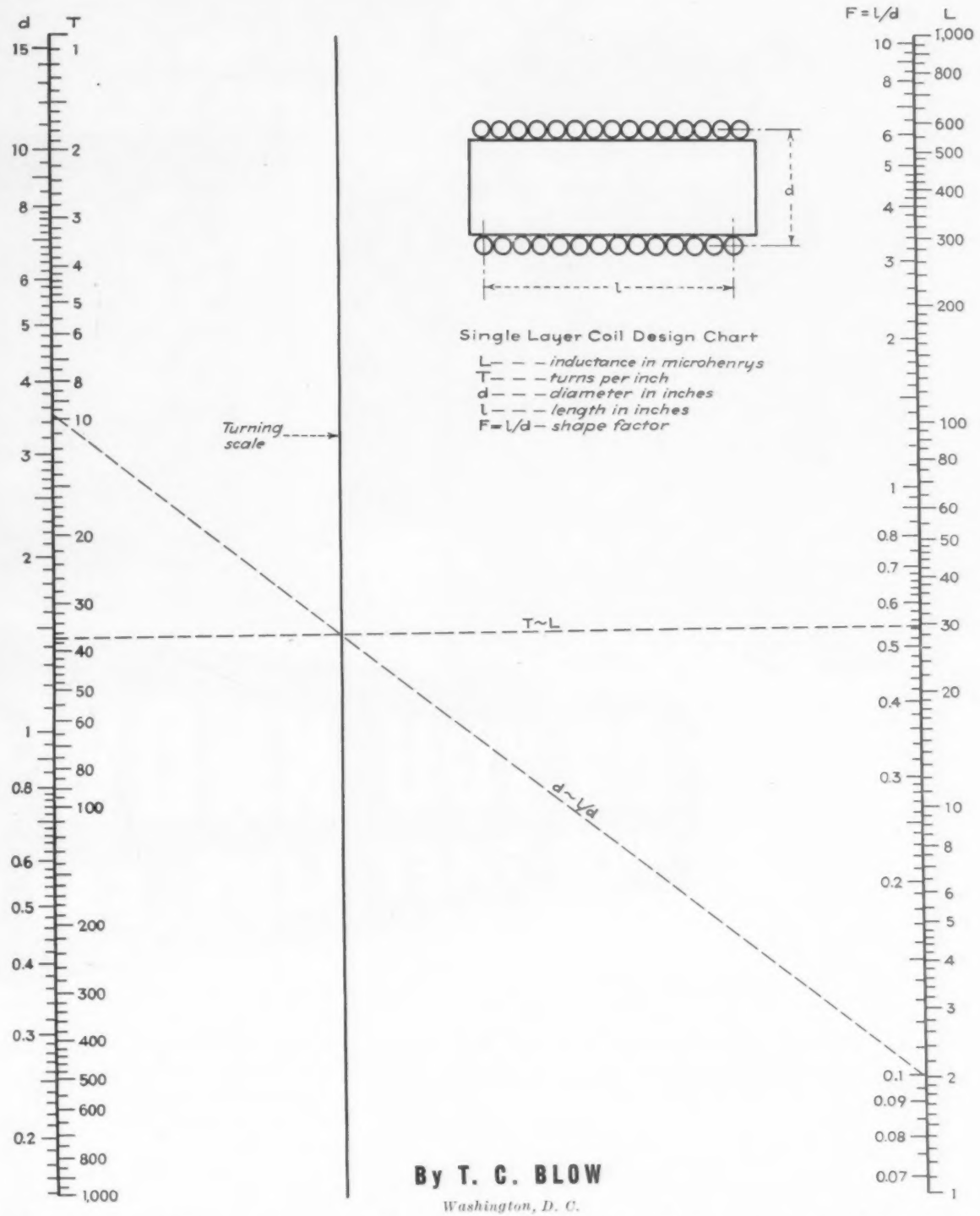
Now, any opaque thing such as a strip of black paper placed within the spot of light will tend to obscure it, the output of the amplifier will drop, and the tension of the bias spring will become dominant over the current in the coil, and the spot will move toward the periphery and remain at the *edge* of the obscuring opaque paper. We can now attempt to intrude still more upon the spot, but it will continue to retreat until the extreme of its arc of travel at the periphery of the chart is reached. The reason this is so, is that the spot is tiny, in the order of 0.005 inch, and the entire output of the amplifier is controlled by a total movement of 0.005 inch of the black paper into the spot. Since the magnitude of the pull of the coil is but a little more predominant than that of the spring, it is necessary to vary the output of the amplifier only a little more than this small amount to give controlling pull to the bias spring, thus requiring an intrusion upon the spot of far less than its full diameter of 0.005 inch to actuate its motion from extreme to extreme of its arc.

It is the slight intrusion of the paper into the spot which maintains the spot at the periphery of the chart. When this condition tends to be modified by moving the opaque paper toward the center of the chart and therefore out of the spot, the spot appears to run after the paper. The spot maintains its relationship to the paper, however, by remaining at its edge throughout the entire movement. The reason for this action is that the movement of the opaque body toward the center of the chart tends to increase the area of the spot and therefore, the amount of light reaching the phototube. The output of the amplifier is increased, and the coil assumes dominance over the bias spring. Thus, the resulting motion of the spot is toward the center of the chart.

It should be understood that the amount of instrusion of the opaque

Design Chart for

Single Layer Inductance Coils



By T. C. BLOW

Washington, D. C.

THE nomogram above can be used with equal facility to determine the number of turns on a given form to provide a desired inductance, or the inductance when the solenoidal winding is specified. If L represents the inductance in microhenries, T the winding pitch in turns per inch, d the diameter of the winding in inches, and l the coil length in inches, any single quantity can be determined when the remaining three are specified.

Example: How many turns of No. 22 enamelled wire (37 turns per inch) are required on a coil 3½ inches in diameter, to produce an inductance of 30 microhenries?

Connect $L = 30$ and $T = 37$ with a straight line, noting the point at which the turning scale is cut. Through this point and $d = 3½$, draw a straight line cutting the scale, $F = l/d$ at 0.1. The number of turns is $N = Tl = TFd = 37\text{x}0.1\text{x}3.5 = 13$.

EDITOR'S NOTE—Due to an emergency at printing time, the page numbers 92, 93, 94 and 95 have been omitted from this issue.

Now we come to another aspect of the this line tracker without which its operation at high speed would not prove feasible. It will be recognized that the coordination of action is such that the system forms a continuous, or rather, an endless chain. For practical purposes, the light source can be considered to originate at the surface of the reflecting mirror M_3. The light proceeds from this mirror to mirror M_2 to the light chamber and phototube, to the amplifier and the output coil. The coil and mirror M_1 rigidly fixed to each other complete the endless chain.

Method of Preventing Oscillation

Assuming perfect conditions, such as an electrical system without phase lag or mechanical inertia, then any disturbance of the relationship of spot to graph would bring an immediate response to correct the disturbing condition. However, the very statement possesses the conditions of impossibility, for it is based upon the premise of cause and effect, that is, time intervenes between the two, and the correction can never be simultaneous with disturbance.

Thus it is, that when a disturbance occurs to alter the degree of contact between the spot and the graph, the correction or response, lagging in time, permits the disturbance to continue to act upon and further alter the spot-to-graph relationship. Finally, when the response or correction does come into play, the inertia of the systems causes an over-compensation which magnifies the original disturbance.

The action of the system under the influence of a disturbance which, let us say, reveals the spot, causes an over-response by obscuring the spot to greater degree than is necessary. The over-response then in turn becomes a cause for an additional over-compensation, and so on. The effect successively increases in amplitude and the mechanism can, under suitable conditions and sufficient amplication, almost tear itself to pieces. Therefore, it is necessary to control the tendency toward oscillation at its inception when the amplitude is minute and the energy necessary to control it is proportionately so.

The flexible contactual relationship between the graph and the spot which, being the basis of the successful operation of the tracking system, is also the place at which disturbances release their greatest reaction, that is to say, mechanical oscillation of the spot, or more precisely acceleration.

Two conditions should be satisfied to produce a most effective method of controlling oscillations. First, the acceleration, being greatest at the moment of its inception, demands the application of counter-effective measures at the moment of genesis. This counteracting power should preferably be automatically graduated in response to present an opposition which is neither insufficient nor excessive, the excess rendering the system unnecessarily sluggish, while a deficiency of control would produce instability and unreliability. Second, the opposing force should be applied before the amplitude of the oscillations reach appreciable level.

The mechanism which controls the oscillation consists of the "oscillation control amplifier" and the two coils P and O, which are respectively the pickup and output coils. These coils and coil A being fixed to each other, the triad of coils will be affected by the reaction of any one coil against the magnetic field in which it is immersed. The pickup coil connected to the grid circuit of a vacuum tube does not generate appreciable current and, therefore, it does not directly influence the other coils by reacting against the magnetic field in which it is immersed. However, it does generate a potential which is proportional to the direction, velocity, and acceleration of its motion, and it is a particular part of this potential, amplified and passed to the output coil O, which produces the useful reaction toward opposing the generation of oscillation.

When a disturbance occurs, the whole moving assembly of three coils and mirror receives the equivalent of an electrical blow, and its mechanical mass does not respond except after an appreciable interval. The reaction is similar to that obtained in a ballistic galvanometer, and the motion is one of acceleration. Therefore, it is desirable that our oscillation control means be limited to a counter-force which is proportional to the acceleration.

The use of a transformer between the output coil and the output of the oscillation control amplifier permits the effective isolation of the desirable counteracting force from those which are of no value for the desired purpose. The transformer preserves the direction of the voltage generated in coil P and also eliminates any current which is derived from a uniform velocity of the pickup coil, because only a changing current, that is, one which is the result of acceleration or deceleration, will be transmitted through it.

The pickup coil is so phased that a potential generated in it produces a current in the output coil O which reacts in a direction to oppose the disturbing motion. Inasmuch as the greatest acceleration is the result of the *tendency* to oscillate, or more precisely, the inception of oscillation, the greatest counteracting forces are brought into play at this time. Thus, the oscillation control system will oppose this type of motion, preserving proper direction and maintaining a counter-effect of proportionate amplitude.

Of course, the line tracker in its normal function of tracking also accelerates and decelerates, but the counter-effect of the oscillation control is minimized and can be reduced to the vanishing point by making the natural period of the system, under oscillating condition, very high compared to the acceleration and deceleration present during normal tracking.

Adjustment of Control

The degree of control exercised by the oscillation control amplifier can be regulated by shunting its output with a variable resistance. No oscillation being visible when the gain control is set to maximum output, this condition changes as the output of the oscillation control amplifier is reduced. The spot begins to oscillate against the graph, not leaving it, but cyclingly intruding upon it and revealing itself more and more as the gain continues to be reduced. This condition can still further be augmented until the spot strikes the graph with such violence that the reaction present in the system as a part of normal line tracking is insufficient to enable the spot to recover its quiescent relationship to the graph. It is then that the graph is jumped by the spot and the contactual relationship is obliterated, and the basis for tracking removed.

(*Continued on page* 202)

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Independent survey shows that 91% of FM radio set owners would recommend them to their friends!

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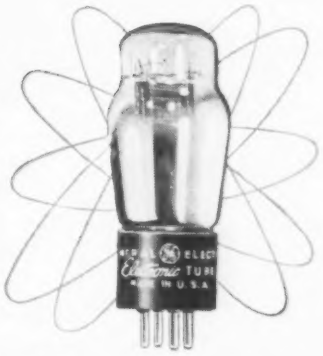
For more detailed information on the FM survey, write for the booklet, "What the Consumer Thinks of FM," to Radio, Television, & Electronics Department, General Electric Company, Schenectady, N. Y.



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Quartz Crystals Oriented by X-Ray Diffraction Method 98
Automatic Air-Raid Alarm for Broadcast Stations Use 100
Foolproof Cuing Systems for Broadcast Stations... 106
Milling Machine Electronically Controlled..... 110
Photoelectric Relay for Batch Weighing, Metering. 112
Transmitting Antenna De-Icer..... 116

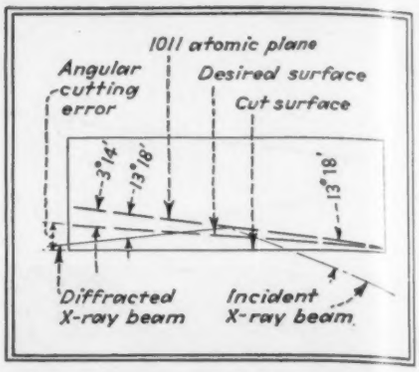


Diagram showing angular relationship between x-rays diffracted from atomic plane and cut desired for AT type crystal

Quartz Crystals Oriented By X-Ray Diffraction Method

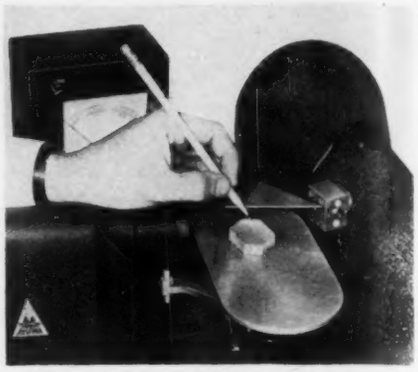
QUARTZ CRYSTAL manufacturers under pressure to produce the maximum number of piezo-electric plates for frequency control of communications and related electronic gear are making effective use of x-ray diffraction apparatus, employing it not only to quickly and accurately determine the location of X and Y axes which must be known in order to make initial cuts having some definite angular relationship with respect to these axes but also to check critical angles and so insure satisfactory activity and conformance with temperature coefficient requirements while plates are in process of manufacture.

Apparatus Design

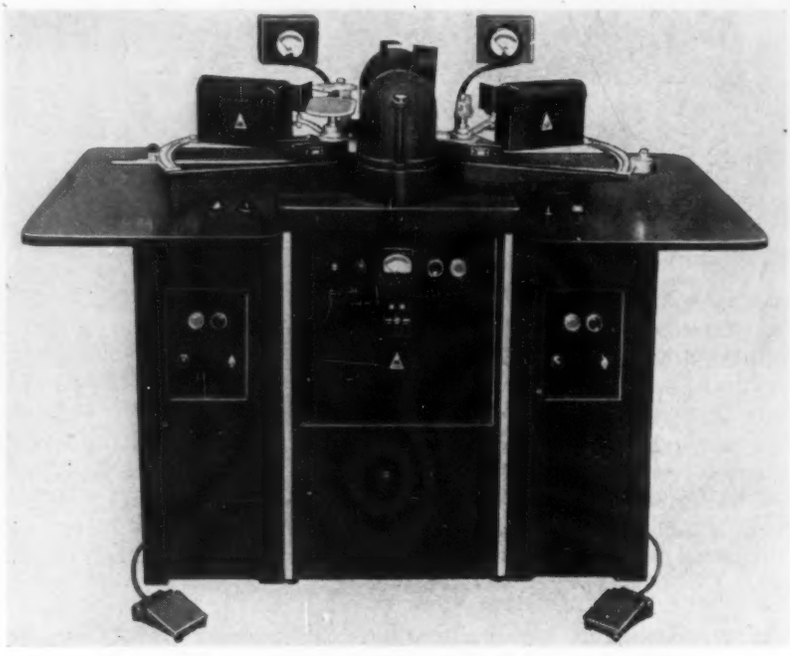
The Philips Metalix Corporation has announced x-ray diffraction apparatus designed specifically for analysis of quartz crystals. Described briefly, this apparatus consists of a source of x-rays, a nickle filter which absorbs $K\beta$ rays without appreciably reducing the intensity of $K\alpha$ rays and so makes emission essentially monochromatic, a slit-type collimator which keeps emitted rays essentially parallel, an ionization tube of the Geiger-Muller type followed by a single-stage (6C5) ballistic amplifier with a 0-1 milliameter in its anode circuit.

Quartz crystals to be analyzed are placed on a rotatable platform or in a rotatable chuck in such a manner as to be interposed in the beam-path between the x-ray tube and the ionization tube. The movable arm of a goniometer calibrated in degrees and minutes is mechanically coupled to the platform or chuck. When work is properly placed and slowly rotated by movement of the arm there will be one critical angle at which there is maximum x-ray diffraction from an atomic plane of the crystal into the ionization tube, indicated by a deflection peak on the associated milliameter. This angle is indicated on the goniometer scale.

There is a definite angular relationship between the atomic plane from which x-rays are diffracted and the X and Y axes of crystals under test on the "natural face" plattorm and between the atomic plane and the surface of plates tested in the rotatable chuck during manufacture, the precise angle of the latter being dependent upon the nature of the crystal cut. It will be seen, therefore, that use of the apparatus provides an accurate starting point from which angles necessary for proper piezo-electric plate performance may be initially determined and later



Close-up of "natural face" orientation table. Rays emanating from the collimator at the right are diffracted by the crystal Z section and collected by an ionization tube contained in the housing at the left. Output of the tube, a Geiger-Muller type, is amplified and deflects the meter seen in the background



Philips Metalix crystal analysis apparatus. The center unit contains a two-tube which radiates x-rays to the left and to the right. The table at the left is used to quickly locate X and Y axes of mother quartz when the Z axis is known. The table at the right is used to check the angles of plates during manufacture

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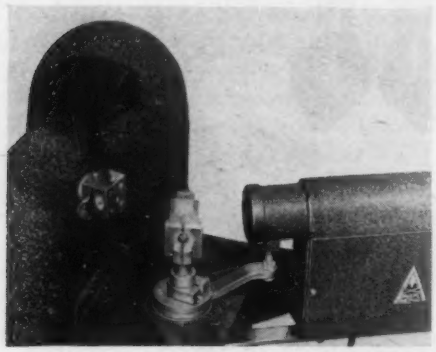
Orienting Unfaced Material

Quartz having no so-called "natural" face may be oriented by the following method: The *Z* or optical axis is first determined by means of a polariscope. A section is then cut perpendicular to the *Z* axis and one face is ground exactly at right angles to this axis. Two small, flat surfaces are rough-ground on the edge of the section perpendicular to the face and at an angle of about 30 deg.



Close-up of table used for checking orientation of semi-finished and finished plates, with protective cover removed. As in the case of the natural face, orientation table, the source of x-rays and the collector are at a fixed angle with respect to each other but the operator can rotate the crystal

The section is then placed on the rotatable platform of the analyzing apparatus, with one of the small surfaces pressed against a stop. The natural side, or prism face, is located by rotating the platform through movement of the associated goniometer arm. When the angle producing maximum x-ray diffraction is found, as outlined above, a pencil guide is brought down over the section and an *X* axis line marked directly on the section. By proper manipulation of the guide other *X* axes and the *Y* axes may be similarly marked.

Where quartz having natural faces is used the method of locating *X* and *Y* axes is, of course, identical except for omission of the polariscope test. A collimator producing parallel x-ray beams in the horizontal plane is used in either case.

Production Check

Quartz plates may be checked as work progresses for maintenance of

Close-up of goniometer. Moving the control lever rotates the crystal under test. The angle of the atomic plane used for test is read directly in degrees and minutes when the x-rays are properly diffracted and the meter reading is maximum

critical angles upon which activity and temperature coefficient depends. When the analysis apparatus is used for this purpose the work is clamped in a chuck and a collimator producing parallel x-ray beams in the vertical plane is used.

One method of utilizing the machine for production control is to determine the angular relationship between the atomic plane from which x-rays are diffracted and the surface of a crystal known to be properly cut and ground. Relatively inexperienced help can then be told that all plates tested must show a milliameter peak within a few degrees or minutes of the standard when the goniometer arm is manipulated. Divergence from the proper angles occurring in production will thus be quickly caught.

The orientation angle of an *AT* or *BT*-cut quartz plate can be checked in about one minute through the use of the machine described.

• • •

An Automatic Air-Raid Alarm for Broadcast Stations Use

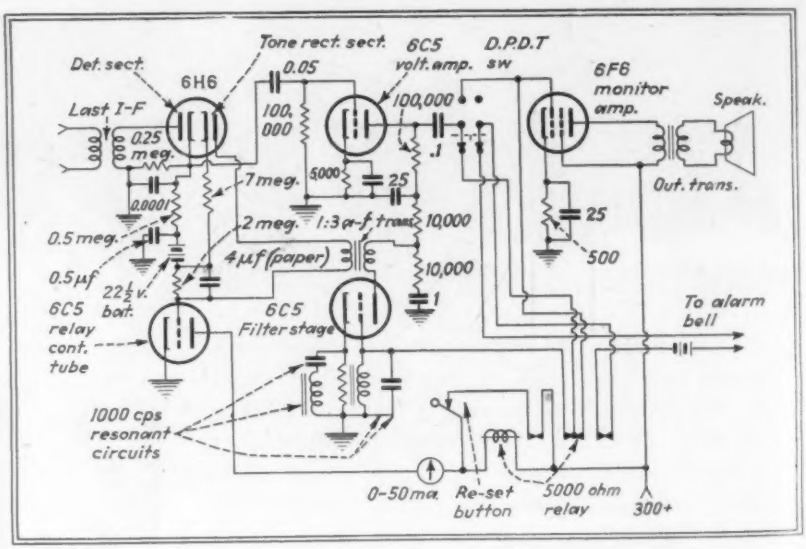
By Victor Voss

Chief Engineer, Station WIND

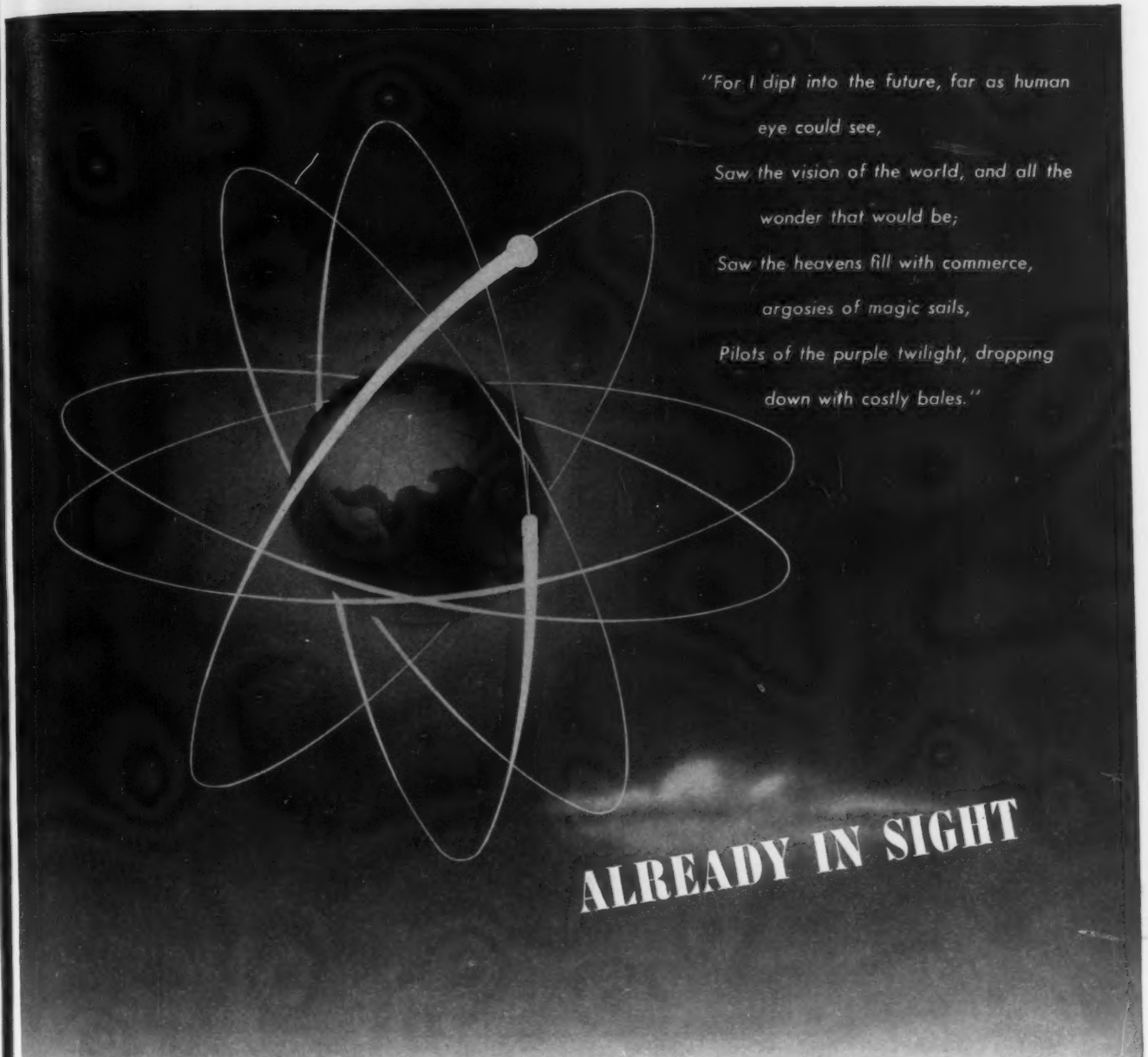
Despite the fact that many automatic air-raid alarm monitors have been described it is felt that the device to be discussed here will be of interest. It remains silent until a 1000 cps warning tone is received and, when this occurs, automatically rings a bell. The bell continues to ring until the operator throws a switch which removes it from the circuit and connects a monitor speaker over which announcements may be heard. Depression of a reset button when the alarm period is over restores the system to its original stand-by condition.

The unit is so designed that it gives warning not only when the requisite 1000 cps tone is received but also in the event that the monitored station carrier, the unit itself or the associated receiver fails. One of the advantages of the circuit diagrammed is its relative simplicity, permitting construction from readily available parts.

The alarm circuit is designed to op-



Schematic of automatic air-raid alarm unit used in conjunction with any superheterodyne receiver capable of providing reasonable output when tuned to the broadcast station to be monitored


"For I dipt into the future, far as human
eye could see,
Saw the vision of the world, and all the
wonder that would be;
Saw the heavens fill with commerce,
argosies of magic sails,
Pilots of the purple twilight, dropping
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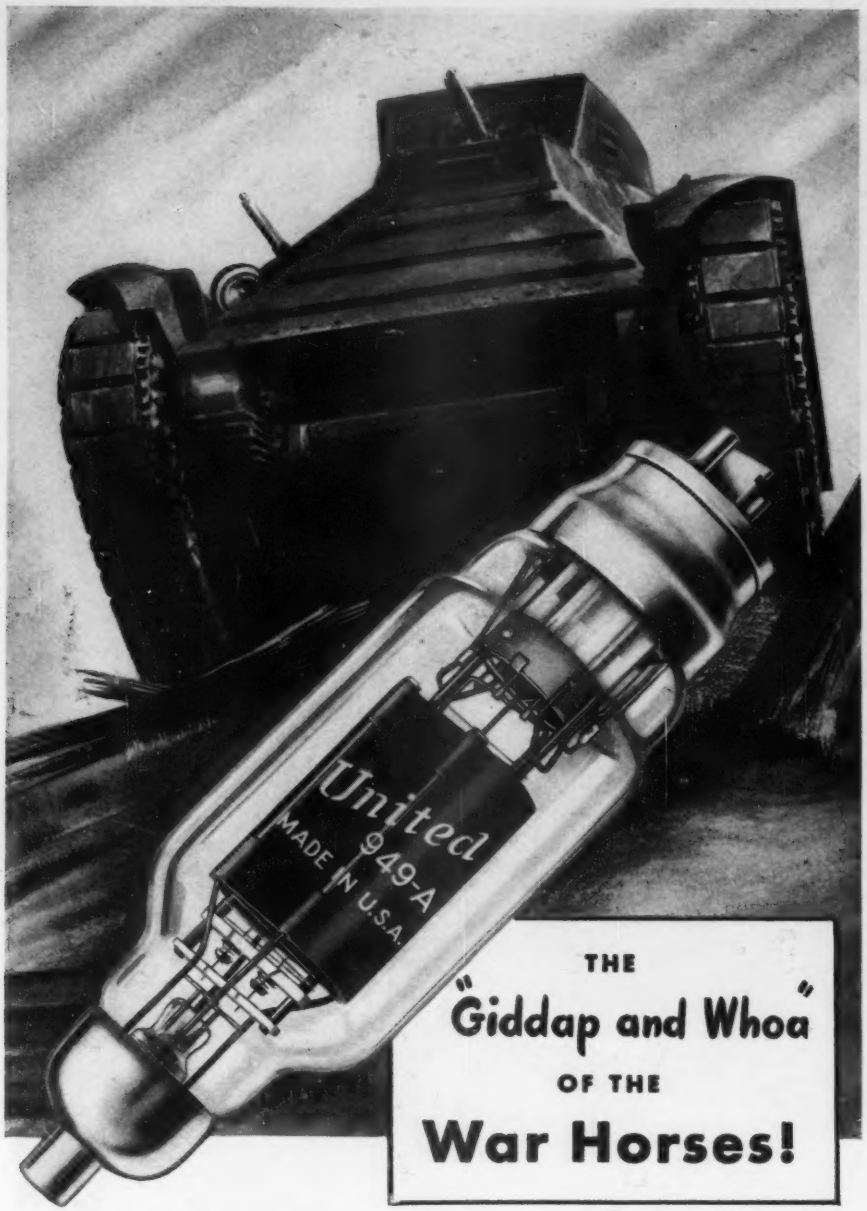

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erate on a 1000 cps tone of 20 to 30 seconds duration. A signal from the last i-f stage of the associated receiver, which may be almost any superheterodyne with sufficient gain to adequately receive the monitored station, is fed to one diode section a type 6H6 which functions as a second detector. This diode section is operated with its cathode above ground.

The Circuit

The audio output of the detector is fed to a type 6C5 used as a voltage amplifier. The voltage amplifier drives a 6C5 "filter tube." The output of the filter tube is fed to the primary of a transformer and voltage developed across the transformer secondary is rectified by the other section of the 6H6. The output of the second diode section of the 6H6 is fed into a relay circuit and appears across a load resistor. This load resistor, a bias battery and the detector diode load resistor are in series with the grid circuit of the 6C5 relay control tube.

(A set of lock-out contacts in series with a re-set button is provided across the relay coil, as shown in the diagram, to maintain the relay in an open position once it operates. A manually operated d.p.d.t. switch is provided. In the "up" position this switch puts the incoming program on a monitor speaker and breaks the automatic alarm bell circuit. In the "down" position the switch puts the program on the filter tube circuit and prepares the unit for automatic alarm operation.)

Operation

The circuit operates as follows:

A 22½ v bias battery provides sufficient negative voltage to cut off the anode current of the 6C5 relay control tube in the absence of an incoming carrier. Because of the manner in which the relay is connected it will be seen that the alarm operates if for any reason the carrier is cut off. Presence of a carrier, on the other hand, develops a voltage across the diode detector load which partially balances out the bias battery, allowing sufficient current to flow in the control tube to close the relay. Under this condition, the alarm circuit is prepared for operation by a tone.

Upon receiving a 1000 cps warning tone, a voltage is developed

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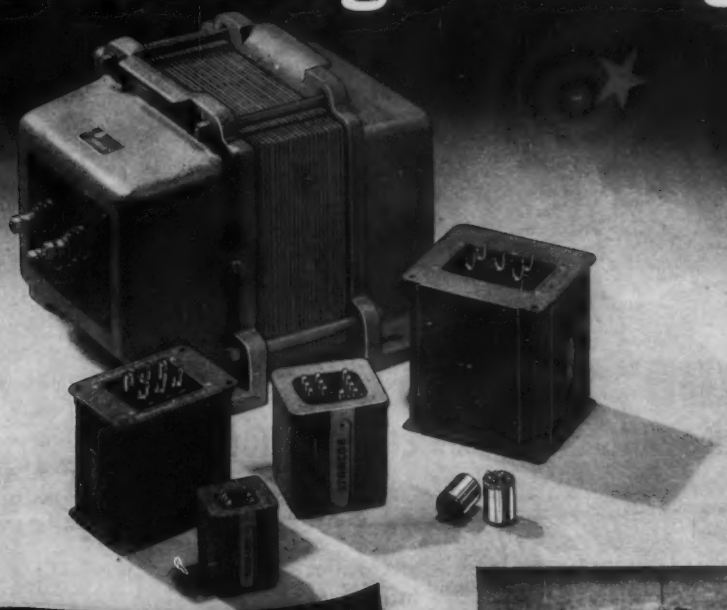

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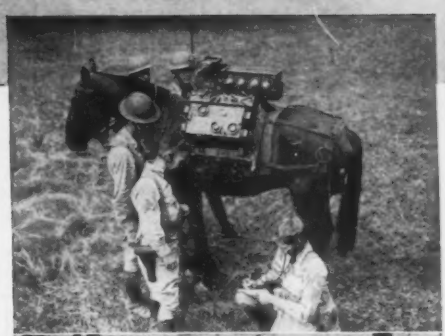

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across the load resistance in the delay circuit of the second 6H6 section. This voltage balances out the carrier voltage developed across the detector diode load resistor, allowing the bias battery to cut off the plate current of the control tube and, consequently opens the relay and produces an alarm. The time required for this action to occur will depend on the gain of the voltage amplifier and filter tubes and the constants of the time delay circuit.

Adjustment

To determine the constants of the 1000 cps resonant circuits the 6C5 voltage amplifier, the filter tube, and the monitor amplifier power tube were first placed in operation. Telephone induction coils were used as inductances, a 1000 cps tone was fed to the voltage amplifier, a volume indicator was placed in the output circuit of the power tube and various shunt and series capacitors were tried in conjunction with the inductances until those which gave the greatest output at 1000 cps, together with the sharpest curve, were found. (A value of 0.12 μf was found best for the particular coils used. The series-resonant circuit across the cathode resistor of the control tube provides degeneration at all frequencies other than 1000 cps and, therefore, additional selectivity.

Next, a small oscillator was built and tuned to an "unused" spot on the super-het receiver dial. This oscillator was suppressor-grid modulated, using the 1000 cps audio oscillator as a modulator and using an oscilloscope to observe when 100 percent modulation was reached. To provide a working point, a value of carrier was decided on which would drive the plate current of the control tube to 20 ma in the absence of modulation. This value had been determined as within the average range of the station to be monitored. Coupling was then adjusted between the oscillator and receiver to give a control tube current of 20 ma with no modulation and the values of the delay circuit components were determined by experiment to allow a delay of 10 seconds between the time the carrier was modulated and the time the relay dropped out. Delay time of 10 seconds is sufficient to eliminate false alarms and yet provides a sufficient safety factor to insure opera-

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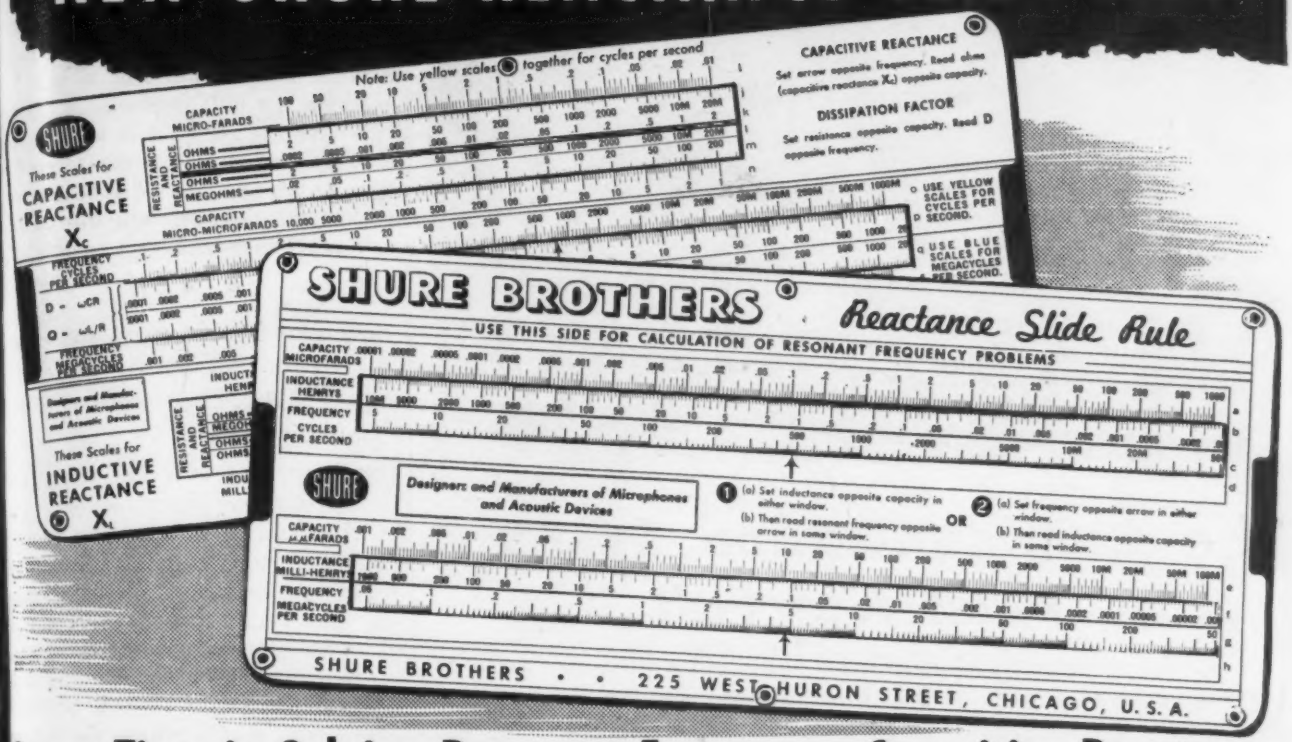
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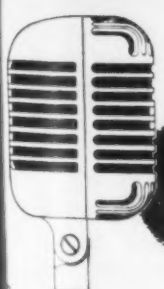
FRONT	EQUATION	SOLVES	RANGE
Resonant Frequency problems	$\omega^2 LC = 1$	1. Resonant Frequency if L and C are known 2. Various L and C values for desired resonant frequency	**Frequency** 5 cycles to 500 megacycles **Capacitance** .001 mmf. to 1,000 mf. **Inductance** .00001 mh. to 10,000 henrys
BACK			
Reactance problems	$X_L = 2\pi fL$ $X_C = \frac{1}{2\pi fC}$ $Q = \frac{2\pi fL}{R}$ $D = 2\pi fCR$	Any single unknown variable, providing remaining variables are known in equations for Inductive Reactance, Capacitive Reactance, Coil "Q", Dissipation Factor	**Frequency** 0.1 cycle to 10,000 megacycles **Capacitance** 1 mmf. to 100 mf. **Inductance** .001 mh. to 100 henrys

Write Shure Brothers, Dept. 174M, 225 W. Huron, Chicago, U.S.A. Sending 10c in Coin or Stamps to cover cost of handling and mailing



SHURE

Shure Brothers, designers and manufacturers of Microphones and Acoustic Devices, are supplying our Armed Forces and our Allies with rugged military microphones for duty on land, on the sea, and in the air. However, you can still obtain our standard line of microphones for vital civilian needs. See your local radio parts distributor—or write for catalog 154M.

The Communication Systems *Must Not Fail*

AS the convoy of vital cargo inches its way toward sea, communication between patrol planes and the ships must be kept open. The communication systems must remain operative at all times for instant warnings of danger.

This is another service requiring transformers fitted to the job—and the long experience of Jefferson Electric in the field of radio and communication systems has been applied to the production of the particular types of transformers required for "walkie-talkies", Naval and airplane communication systems.

Realizing that failure of but one transformer may cause the loss of men, ships, planes and vital cargoes, our engineers and production force have taken additional steps to safeguard the traditional and uniform high quality which is more necessary today than ever before. JEFFERSON ELECTRIC COMPANY, Bellwood (Suburb of Chicago), Illinois. Canadian Factory: 60-64 Osler Avenue, West Toronto, Ontario.

Vital War Jobs for
JEFFERSON
Transformers

Gun-firing Transformers, radio and communication system Transformers,—Ballasts used with fluorescent lamps that light our war factories,—Fuses to protect electrical equipment and systems,—ML Transformers to insure good mercury lamp performance,—Power-Circuit transformers that save copper and provide the circuit voltages desired,—Control Transformers,—all are widely used in our War production effort . . . Jefferson Electric engineers offer recommendations based on a quarter of a century of specialization in the small transformer field.

★

JEFFERSON ELECTRIC

TRANSFORMERS

tion of the system on a 20 to 3[illegible] second tone.

The relay used has a d-c resistance of 5000 ohms, opens at 6 ma and closes at 12 ma. It is important that a high resistance relay be used and if one of sufficient sensitivity but having a lower resistance is on hand a series resistor must be added.

When the unit is placed in operation receiver r-f gain is adjusted so that the carrier of the monitored station drives the control tube current to 20 ma. Current will dip only a few ma under ordinary modulation.

• • •

Foolproof Cuing System for Broadcast Stations

By JOSEPH ZELLE

WABC, Columbia Broadcasting System

BROADCAST STATIONS frequently use part of their regular channel equipment in special circuits, for routine tests and other similar operations. Unless precautions are taken temporary circuits may cause embarrassment when programs are placed on the air. The accompanying diagram illustrates a simple change-over circuit which reduce the human error to a minimum. The success of its operation is entirely dependent upon the type of switch used. Among those suggested are the Western Electric type 479 non-locking key and the type 392 push-button key. Where remote control is required a type "E" relay made by the same company can be substituted in conjunction with a push-button, or the relay may be actuated by other conventional means.

A specific application of this circuit is in the control room of a broadcast studio. The studio engineer must frequently "spot" or "cue" records before going on the air. That is, he must set the pickup needle about a half turn ahead of the music to allow the turntable to attain normal speed and must still start playing immediately after the announcer's introduction. In order to cue the record, part of the regular circuit must be used temporarily without placing it on the air. Sometimes the operator blunders when switching.

Circuit Details

The cuing system presented here provides a mechanical safety feature which is practically foolproof

HEADQUARTERS FOR ACCURATE, INFORMED Local Order Service
Your local RCA Tube and Equipment Distributor is headquarters for the following items, and, equally important, for the all-essential "know how" of their application and use:
RCA, CUNNINGHAM, and RCA VICTOR RADIO TUBES
RCA SPECIAL PURPOSE TUBES, POWER TUBES,
PHOTOTUBES, CATHODE RAY TUBES, etc.
RCA ELECTRONIC TEST EQUIPMENT
. . . also condensers, resistors, rheostats, controls, potentiometers, coils, wire, and numerous other radio and electronic components produced by many manufacturers.
RUSH

OVER 300 RCA TUBE AND EQUIPMENT DISTRIBUTORS

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WHETHER your need is for one electronic item or a dozen, your RCA Tube and Equipment Distributor is geared to help you select it and get it as rapidly as possible! The fact that there are over 300 of these distributors throughout the nation means that there is one close by—ready to deliver personalized, 'round-the-corner service.

RCA Tube and Equipment Distributors not only afford a convenient, 'round-the-corner source of supply, but back their merchandise with a technical knowledge that has proved invaluable.

If you do not already know the name of your nearest RCA Distributor, write or wire us today.

Put his services to work in solving your electronic equipment buying problems. Take advantage of the large and varied stocks he normally maintains. Let him serve as your specialized "expediter." Ask him for the technical suggestions he is so well qualified to give!

RCA MANUFACTURING CO., INC., Camden, N. J.

AN ADVERTISEMENT OF THE RCA TUBE AND EQUIPMENT DIVISION IN THE INTEREST OF GREATER SERVICE AND EFFICIENCY IN PRIORITY-COVERED WAR MATERIALS BUYING

ARMY E NAVY

"FROM that high resolve was born the Army-Navy Production Award which stands today as our fighting forces' joint recognition of exceptional performance on the production front . . . of the determined persevering, unbeatable spirit which can be satisfied only by achieving today what yesterday seemed impossible!"

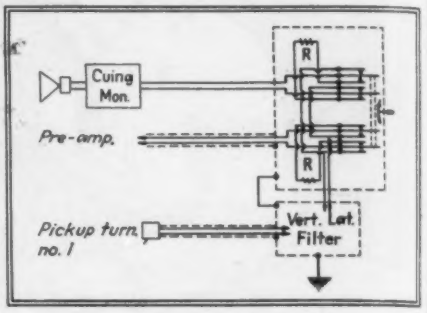
We're sincerely proud of our award —its significance will always be our goal.

BLILEY ELECTRIC COMPANY · · · ERIE, PA.

Bliley Crystals

It is simple to install and parts can be salvaged from almost any radio shop. Readily available switches can be easily revamped to make and break the necessary circuits.

With the key in the neutral position the cuing monitor is disconnected. To operate the cue monitor the operator simply holds the key in the cuing position. Since the key (or relay) is non-locking, there will be no danger of putting the pickup on the air as long as the key is held down. Releasing the key will connect the pickup to normal circuits. Thus, once the studio engineer becomes accustomed to "push to cue" it will become second nature with him.



Circuit of foolproof cuing system. The value of input-shorting resistors *R* is not critical

The system especially proves its worth during moments of confusion or programming error, when time is at a premium. With this system the controlroom engineer can quickly cue the record with perfect confidence, and worry only about the program detail to be aired. The moment he releases the key after cuing, the pickup will be on the air if the regular gain control is open. Furthermore, since the pickup is monitored after the "Vertical-Lateral Filter" control, the danger of playing transcriptions with the wrong filter is virtually eliminated.

Installation

Installation is simple. The shielded leads from the filter and pickup in the turntable cabinet are cut and the switch inserted as shown in the diagram. Then, to prevent accidental open inputs, resistors *R* are so placed that they short-circuit either the cuing monitor or pre-amplifier when these are not in use.

The cuing monitor can be placed in the turntable cabinet to avoid complicated wiring.

INTELLIGIBILITY

Built to Civil Aeronautics Administration specifications, CAA-515, the Electro-Voice Model 7-A microphone is widely used for airport landing control and is highly suitable for many other sound pick-up applications.

The smooth frequency curve, rising with frequency, gives extremely high intelligibility even under adverse conditions. Desk mounting incorporates easily accessible switch which can be operated by thumb of either right or left hand. Microphone may be moved without danger of pressing this switch.

SPECIFICATIONS

SWITCH: Push-to-talk Acro-switch, SPDT, for relay operation; positive action; slight pressure required for actuation; 1/16" over-travel; connections terminate on terminal strip in base.

OUTPUT IMPEDANCE: 25 ohms.

CABLE: Eight feet, 4 conductor, shielded, overall rubber jacket, equipped with MC4M connector.

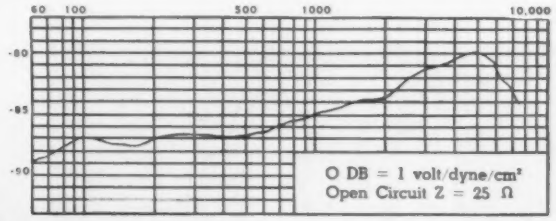
DISTORTION: Not exceeding 5% for sinusoidal sound waves from any direction from 100-4000 cps, up to 50 dynes/cm².

INSULATION: Leads from the moving coil are insulated from the microphone housing and stand, and are capable of withstanding 500 volts RMS, 60 cps.

STAND TUBE: Wear resistant, ⅛" XXM bakelite.

CORROSION RESISTANCE: The entire microphone is completely inhibited against corrosion and will successfully withstand a 20% salt spray atmosphere for 100 hours at 95° F.

NET WEIGHT: 3½ lbs.; Shipping wt.: 5 lbs.



This Model 7-A Desk Mounting Communication Microphone supersedes our previous Model S-7. Our Engineering Department may be able to assist you with your microphone problem. *Electro-Voice Manufacturing Co., Inc., 1239 South Bend Avenue, South Bend, Indiana. Export Division: 100 Varick Street, New York, N. Y., U. S. A. — Cable Address: "Arlab"*

Electro-Voice MICROPHONES

WE'VE MADE BILLIONS

—and not one has loosened

THEY'RE on oil well pumps—some for twelve years.

They're standard equipment on rock drills — industry's toughest fastening problem.

They're on tanks, planes, guns—all kinds of wartime material—all kinds of peacetime equipment.

All told, billions of Elastic Stop Nuts have gone to work.

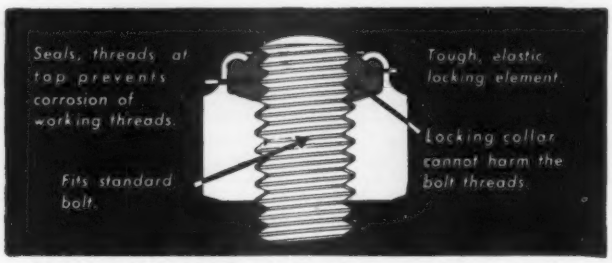
And as far as we know, not one has failed to do its job.

That job is to hold fast and stay put—come what may in the way of vibration, jar or chatter.

Of course the need for such dependable fastenings in war goods and planes is paramount. Some planes take as many as 35,000 in a single ship.

So even at our 4,000,000-a-day rate (which soon will double) the demand keeps growing.

But this constant call for more and more—to meet the exacting responsibilities of war—gives ample proof that Elastic Stop Nuts answer every need for secure locking and speedy fabrication.


Seals, threads at top prevents corrosion of working threads.
Tough, elastic locking element.
Locking collar cannot harm the bolt threads.
Fits standard bolt.

Write for folder explaining the Elastic Stop self-locking principle.

ELASTIC STOP NUT

CORPORATION OF AMERICA

2330 Vauxhall Road, Union, N. J.

WITH THE RED COLLAR — SYMBOL OF SECURITY

Milling Machine Electronically Controlled

AN ELECTRONIC UNIT provides automatic cyclic control of the d-c feed motor in a Plan-O-Mill Corporation planetary milling machine. Started when a button is depressed, the control feeds the milling cutter into the work at a pre-selected speed, automatically switches a few seconds later to another pre-selected speed for feed-around, rapid-reverses the feed motor at the end of the milling operation and shuts off the motor at the end of the cycle.

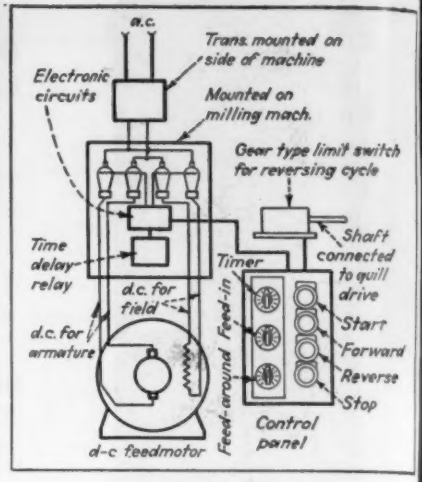


Fig. 1—Elemental diagram of circuit used to control motor-speed and cyclic operations on planetary milling machine

The control system employs tubes to convert a.c. into controlled d.c., providing variable armature and field voltages for the d-c feed motor. A circuit diagram of the system is shown in elemental form in Fig. 1. The top one of three variable controls mounted on a panel placed at a position convenient for the operator permits adjustment of time-delay and changing of the speed of the feed motor at the instant when feed-in stops and feed-around begins. The middle control sets the speed of the feed motor during feed-in. The bottom control adjusts feed-around speed. A gear-type limit switch throws the feed motor into rapid-reverse at the end of the milling operation.

Motor speed can be pre-determined within close limits. Control is obtained by varying motor armature voltage while holding the field voltage constant at lower rotation speeds and by varying the field voltage while holding the armature

"...Image is blurred on band four"

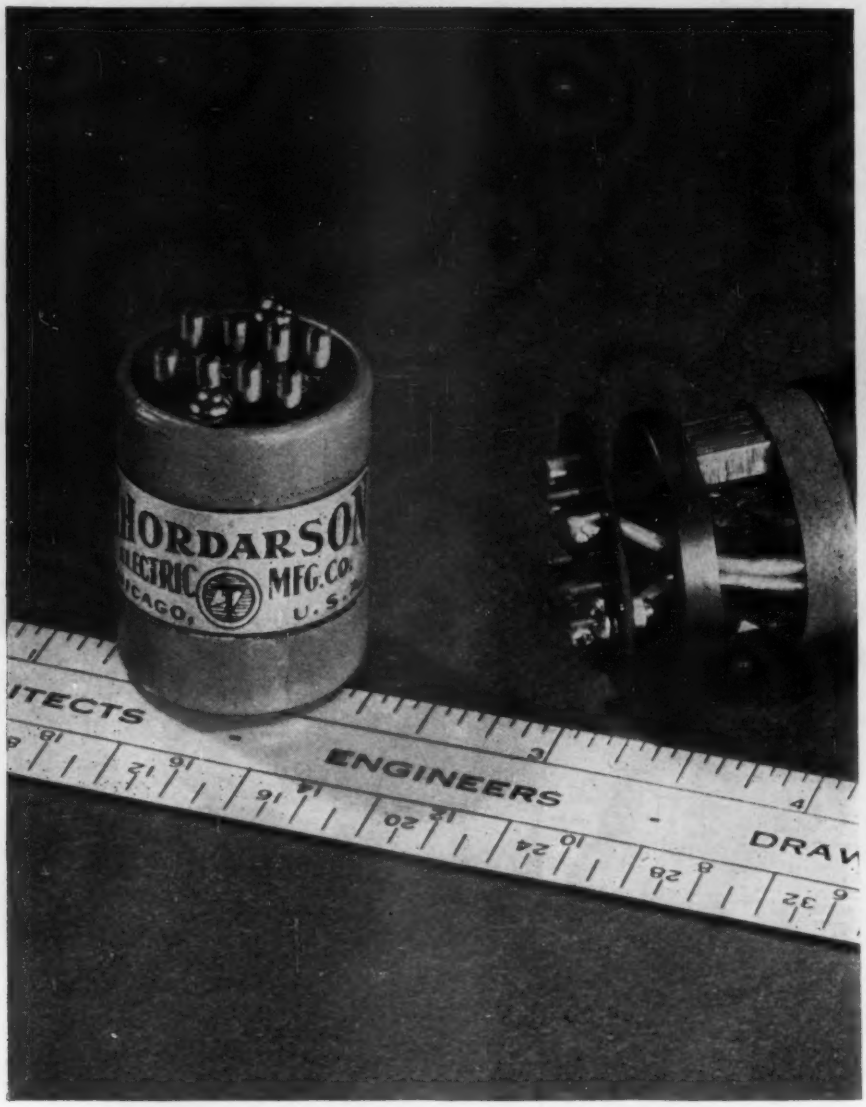
SOME BRIGHT DAY in the world of peace to come, Mr. and Mrs. America may be replacing television tubes as casually as light bulbs. You don't need Alladin's lamp to conjure up a houseful of new and fascinating electrical appliances to come after the war is won. And of this, too, you can be sure: When television-for-the-many is here, along with other new and brilliantly engineered products of electrical science, Jackson will be making laboratory and service shop testing instruments to meet tomorrow's needs *in full*. Today, Uncle Sam's needs come first. And while we cannot fill your orders now, just remember that the name Jackson has earned a high reputation wherever fine test equipment is used.

JACKSON ELECTRICAL INSTRUMENT COMPANY, DAYTON, OHIO.

All Jackson employees—a full 100%—are buying War Bonds on a payroll deduction plan. Let's *all* go all-out for Victory.

JACKSON

Fine Electrical Testing Instruments



If You Lack Transformer Space ...You Need a Thordarson Incher

Thordarson Tru-Fidelity Incher Series Audio Transformers are specially designed for use where weight and size are as important as quality. There are many types with frequency response performance within —1.5 db from 30 to 15,000 c. p. s. Single plate to grid types for dc in primary are available for voice frequencies.

Thordarson Incher Transformers are protected against moisture by vacuum impregnation of the coils and by hermetically sealing the core and coil assemblies in moisture-proof compound.

For 48 years Thordarson engineers have been designing and building better transformers . . . no matter how complicated your transformer requirements may be, send your specifications to Thordarson.

INCHER CASE DIMENSIONS
Diameter 15/16 in.
Height (Incl. lugs) 1 1/4 in.
Height (Case alone) 11/8 in.
Weight 1 1/4 oz.
Mounting Centers 23/32 in.

Many other types illustrated and described in Catalog No. 500

THORDARSON
500 W. HURON ST., CHICAGO, ILL.

TRANSFORMER SPECIALISTS SINCE 1895

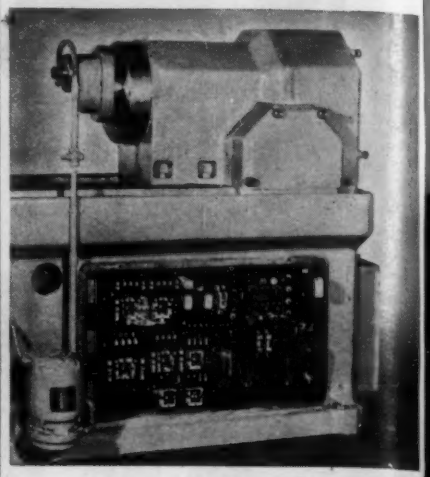


Fig. 2—Back of milling machine, showing panel containing all electronic equipment with protective cover removed

voltage constant at higher rotation speeds. A panel located at the rear of the milling machine, shown in Fig. 2 with its protective cover removed, contains all electronic control equipment. Included is a thermal relay which shuts off the feed motor before sustained overloads can cause damage and an electronic brake operating in conjunction with the auxiliary motor seen at the lower left in the photo to avoid loss of time waiting for the cutter to slow down.

• • •

Photoelectric Relay for Batch Weighing, Metering

DESIGNED by the United Cinephone Corporation, a light and compact two-unit photoelectric relay simplifies commercial and industrial operations utilizing pointer-and-scale type weighing devices for automatic control of processes such as batch-

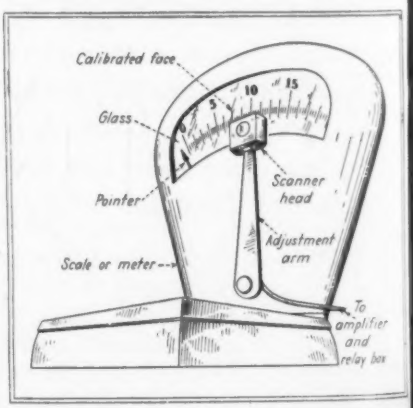


Fig. 1—Photoelectric relay applied as an external accessory to a pointer-and-scale type weighing device

Cut Recruit Training Period of Your Screw Driver Army

ANYONE CAN DRIVE PHILLIPS SCREWS!

In many of today's war-expanded plants, *raw recruits* now literally walk from the employment office into responsible screw-driving jobs previously rated as skilled work. They produce efficiently, too, because the job is simplified and made foolproof by Phillips recessed head Screws.

The Phillips driver centers *automatically* in the recess . . . can't slip out to injure hands or spoil the work. This means centered *driving force* . . . no fumbling, wobbly starts . . . no slant-driven screws . . . no burred or broken screw heads.

Snug fit and perfect centering of driver in the Phillips Recess enable workers to make *uniformly tight* fastenings . . . and do it with *less effort.* Driving speed is often *doubled* because easy-driving, skid-proof Phillips recessed head Screws make power-driving practical!

They cost less to use! Compare the cost of driving Phillips and slotted head screws. You'll find that the price of screws is a minor item in your total fastening expense . . . that it actually costs less to have the many advantages of the Phillips Recess!

KEY TO FASTENING SPEED AND ECONOMY

The Phillips Recessed Head was scientifically engineered to afford:

Fast Starting – Driver point automatically centers in the recess . . . fits snugly. Screw and driver "become one unit." Fumbling, wobbly starts are eliminated.

Faster Driving – Spiral and power driving are made practical. Driver won't slip out of recess to injure workers or spoil material. (Average time saving is 50%.)

Easier Driving – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

Better Fastenings – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

21 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Reading Screw Co., Norristown, Pa.
Pheoll Manufacturing Co., Chicago, Ill.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

ing and container-filling. The relay is readily adaptable for use in connection with weighing devices of the type illustrated in Fig. 1 and may, obviously, be employed in conjunction with reasonably large meters used for measuring values other than weight. Construction is such that the relay may be applied externally to existing apparatus, in a manner such as that shown, or may be incorporated within weighing devices or meters of the larger variety during manufacture.

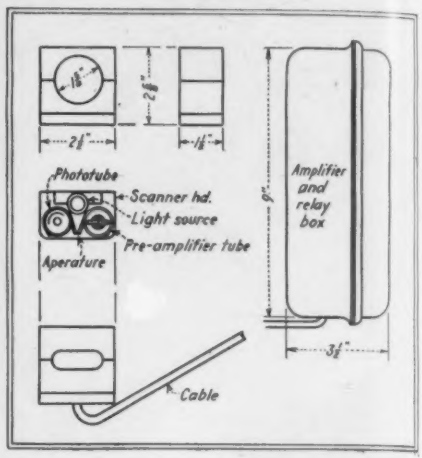
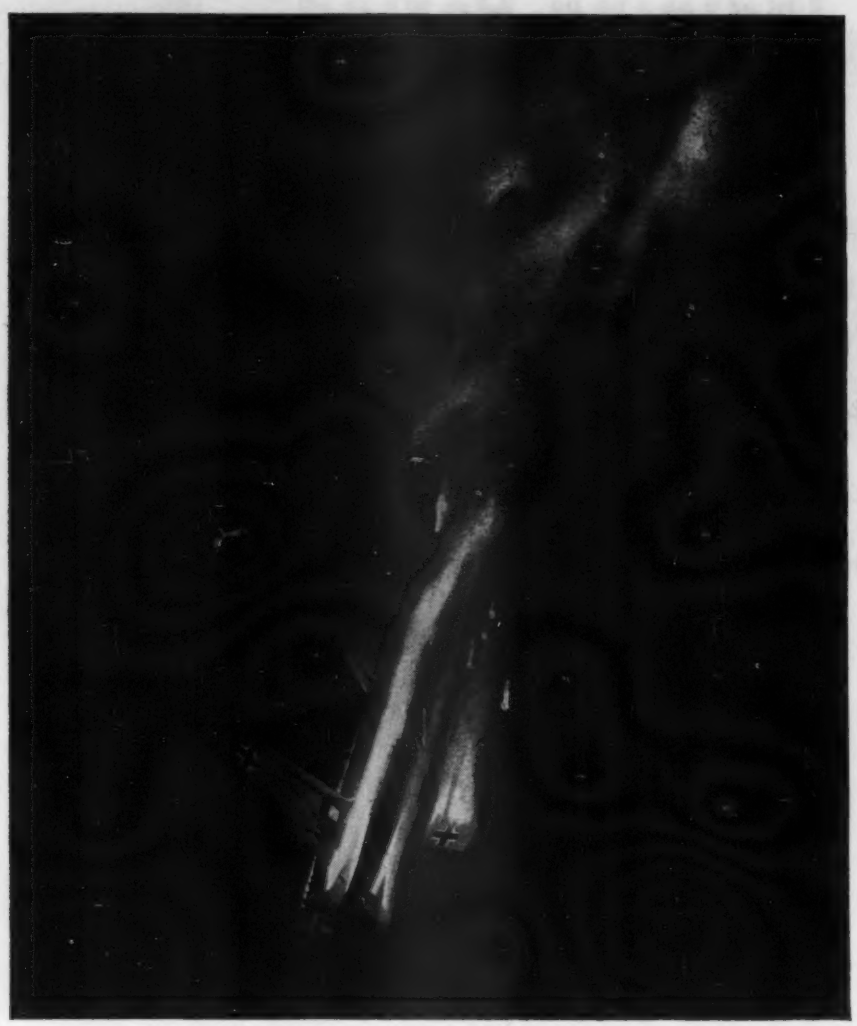


Fig. 2—General arrangement of parts within scanner-head, with dimensions of both photoelectric relay units

Referring to Fig. 2, it will be seen that the relay comprises a scanner head in which a light-source, an aperture, a phototube and a pre-amplifier tube are incorporated. The scanner-head may be affixed to a suitable arm in such a way that a beam of light strikes the calibrated face of the weighing device at a point through which the pointer of the weighing device passes, preferably with the beam-path an inch or less long between scanner-head and face. The supporting arm may then be adjusted so that the weighing device pointer passes through the light-beam between scanner-head and face at any value within the available measurement range. Two scanning-heads may, of course, be utilized where control is required at both low and high values.

In operation, the scanner-head projects a light-beam to the calibrated face of the weighing device and a quantity of light dependent upon the reflective capabilities of the face is returned to the phototube within the scanner-head, causing it to bring the anode current of the pre-amplifier tube within the head to



BULL'S-EYE IN THE DARK

Stabbing out into the black of night . . . locating winged raiders . . . downing an unseen enemy . . . electrical and electronic devices are helping United Nations win mastery of the air.

Today, the Allies are benefiting by the years of peacetime research. Companies long active in the radio industry, like Utah Radio Products Company, are turning the skill of their laboratories to the manufacture of weapons for war.

Utah dependability, long a byword in the radio industry, is being built into all kinds of electrical and electronic devices, for the Navy, Army and Air Corps. We would like to tell you this whole story of Utah developments, but that would be interesting to the enemy, too; so the full details will have to wait until after the war.

Then, when America is back in the swing of peacetime activity—American homes and factories will benefit from the wartime research and improvements that are now going on at Utah. Re-united family circles will have greater convenience and enjoyment. Industrial production will be assured of greater economy and efficiency. UTAH RADIO PRODUCTS COMPANY, 812 Orleans St., Chicago, Ill.

Utah

PARTS FOR RADIO, ELECTRICAL AND ELECTRONIC DEVICES, INCLUDING SPEAKERS, TRANSFORMERS, VIBRATORS, UTAH-CARTER PARTS, ELECTRIC MOTORS

Let Hytron Break that Bottleneck!

900%
800%
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300%
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100%
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HYTRON

WAR-PRODUCTION SHIPMENTS UP 700%

In spite of this big increase, Hytron has available:

IMMEDIATELY — large capacity for certain types of radio and electronic tubes.

IN SECOND QUARTER — still larger capacity for almost all types which Hytron is tooled to make.

IN THIRD AND FOURTH QUARTERS — capacity almost unlimited for all types suited to Hytron's production lines.

If you place your orders now, Hytron's fast-rising productive capacity can smash those bottlenecks caused by tube shortages.

HYTRON CORP., Salem and Newburyport, Mass.

Manufacturers of Radio Tubes Since 1921

HYTRON RADIO TUBES

and for FREEDOM *from Solder Failure*

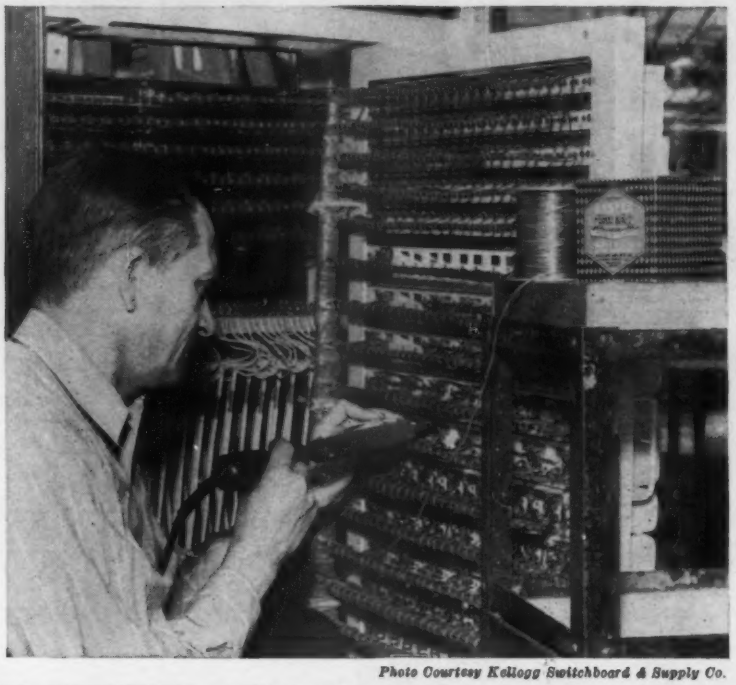


Photo Courtesy Kellogg Switchboard & Supply Co.

KESTER CORED SOLDERS

• **Solder today is a vital war material! Wherever it is used in production of fighting machines and the equipment that goes into them—in safeguarding heavy-duty or delicate electrical circuits; in general metal-joining applications; in *any* of its many important uses—it *must hold tight!***

• **Kester Cored Solders measure up to the most exacting war jobs. They expedite production, *safely* — flux and solder, both in proper kind and amount, are applied in one simple operation. The high effectiveness of Kester fluxes and superior quality of Kester alloys insure permanent results, an unequalled resistance to bending, vibration, shock, contraction and expansion.**

• **Kester Rosin-Core Solder, for electrical applications, contains a special, patented plastic rosin flux that won't injure insulating material or cause corrosion. Kester Acid-Core Solder, for general use, makes a tight, clean, permanent union.**

• **All Kester Cored Solders are available in a wide range of core and strand sizes, meeting every production requirement. Consult Kester engineers freely, without obligation, on any soldering problem.**

KESTER SOLDER COMPANY
4204 Wrightwood Avenue, Chicago, Illinois
Eastern Plant: Newark, N. J. Canadian Plant: Brantford, Ont.

Silver-Lead Alloy. **Kester is prepared to offer, for test on your work, a wartime solder of silver and lead in both cored and wire form.**

KESTER
Cored Solders
STANDARD FOR INDUSTRY

some nominal value. When the pointer of the measuring device moves into the light-beam there is a change in the quantity of light reflected to the phototube and, consequently, a change in the pre-amplifier tube anode current. This change actuates a succeeding amplifier tube contained within the second unit of the device through a connecting cable and causes a relay to operate. The relay may be connected to control external circuits associated with the commercial or industrial operation in progress.

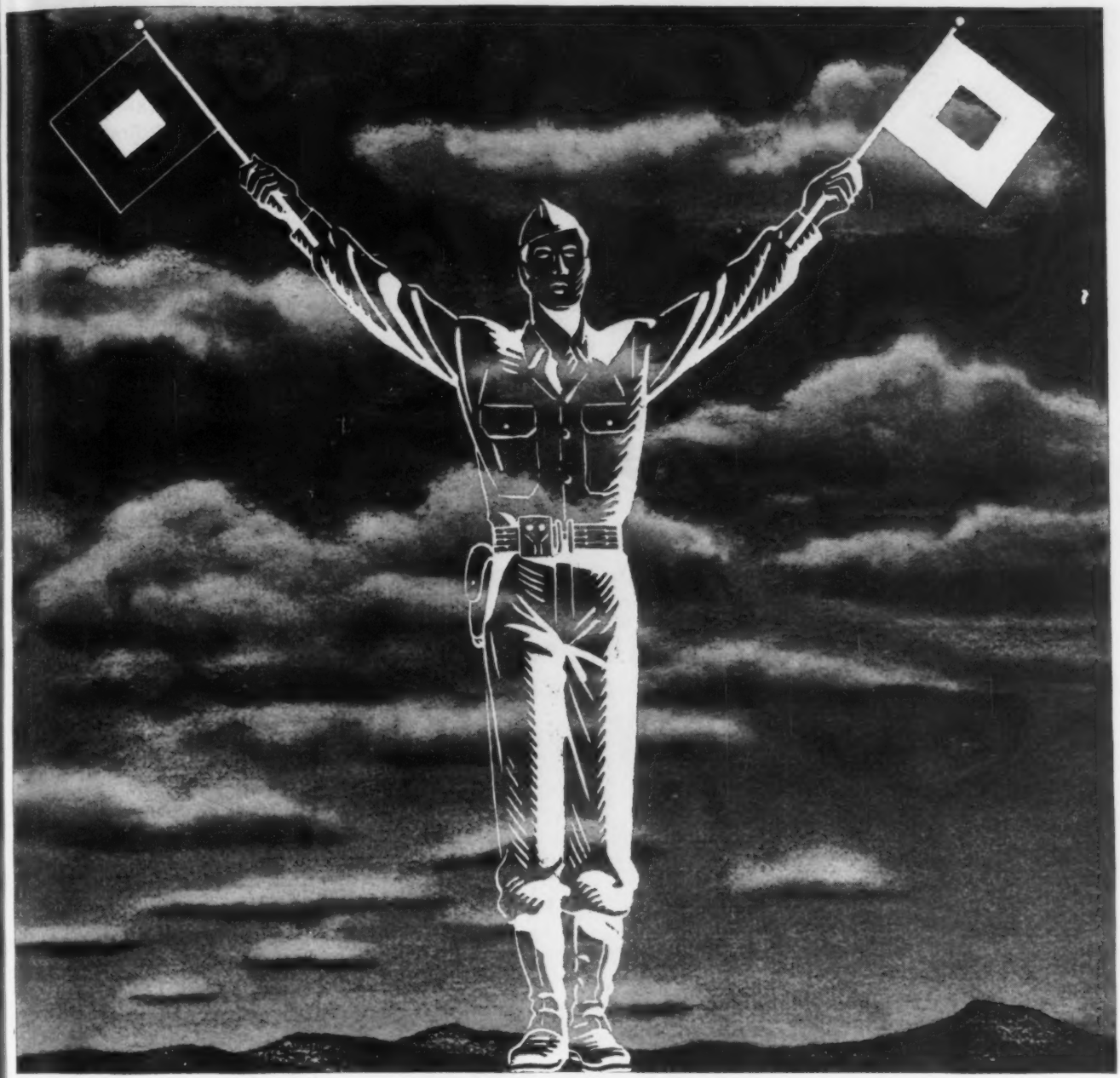
The device described is applicable to pointer-and-scale instruments with faces from which little or no light is reflected as well as to those from which considerable light is returned to the scanner-head phototube inasmuch as it is sufficiently sensitive to operate on the *differential between* light reflected by the average pointer and scale and does not depend upon interruption of light reflected from the scale for operation. Effectiveness of the relay when it is necessary to mount the scanner head more than an inch away from the calibrated face of the scale depends largely upon the contrast in reflective ability between the instrument's face and pointer and the amount of light reflected by any glass incorporated within the weighing device to protect its pointer and face.

• • •

Transmitting Antenna De-Icer

ELECTRIC HEAT is used by FM station W51R at Rochester, N. Y., to prevent formation of ice on its transmitting antenna, high up on top of a downtown building. The antenna consists of two sets of hollow cross arms mounted one above the other, "turnstile" fashion, in a horizontal plane. Formation of ice would not only reduce radiation efficiency but might also endanger passersby in the street below.

A four foot "Calrod" electric heating unit has been built into each of the cross arms. Current for these heaters is turned on automatically when temperature drops within the sleet-forming range by two thermostats mounted on the antenna mast. Both thermostats must be closed to operate the heaters. One thermostat closes when the temperature falls below 32 deg. and the other functions when it falls below 28 deg. F.



U. S. SIGNAL CORPS! When the smoke of battle fades and historians record the heroic deeds of men and armies —only then will we fully appreciate the important role of the U. S. Signal Corps in this world conflict! Our victories on the field and in the air can be attributed in a great measure to the sacrifice, skill and courage of the men in this branch of the armed services. They are in fact the nerve-center of our fighting forces.

COURTESY OF
JEFFERSON-TRAVIS RADIO MFG. CORP.

NEW YORK, N. Y. WASHINGTON, D. C.

The fundamental purpose of every Cannon Connector is to connect electrical circuits quickly and securely. This theme is expressed by a single Cannon contact pin and its corresponding socket. The addition of more pins and sockets to handle more circuits is simply a variation of this fundamental theme. This means the same basic uniformity of quality and dependability in a comprehensive line of standard Cannon Connectors.

Today, *standard* Cannon Plugs are supplied in the type, style and size required for connecting nearly every circuit used in modern electrical control and communication systems. So complete is the Cannon Line that it is difficult to find a requirement that cannot be filled by a standard Cannon Plug.

Tell us your needs and we'll gladly suggest the *standard* Cannon Plug which best fits your *special* job. Cannon standardization speeds up assembly operations . . . makes inspection and service easier . . . and assures uniform dependability under all conditions.

CANNON ELECTRIC

Cannon Electric Development Company, Los Angeles, California

Canadian Factory and Engineering Office: Cannon Electric Co., Ltd., Toronto, Canada

REPRESENTATIVES IN PRINCIPAL CITIES—CONSULT YOUR LOCAL TELEPHONE BOOK

Detecting Smoke in Blood

FIREMEN and other victims of smoke-poisoning are hard to treat because the smoke gets in the bloodstream and the nature of first-aid measures depends to some extent upon the amount of it found there. Smoke discolors the blood but frequently not enough to be readily detected by the naked eye.

A color-sensitive electronic device is being developed especially for the purpose of determining the degree of exposure to smoke. It will, engineers working on the problem hope, tell a physician what he wants to know in a matter of seconds.

• • •

Black-Light Lamps for Maps

A TRANSPARENT PLASTIC envelope which converts invisible near-ultraviolet light into weak and diffused visible light which will not affect night vision of bomber crews is described in the last issue of *Aviation* magazine. Maps, photographs, orders or other printed material placed in these envelopes are illuminated sufficiently for readibility when in contact with this new fluorescent, transparent orange-red plastic material developed by J. M. Gordon, fluorescent and luminescent products consultant. The envelopes can be made in practically any desired size, from small card holders to map or chart containers. Penciled messages can be written directly on the envelopes, and erased for re-use.

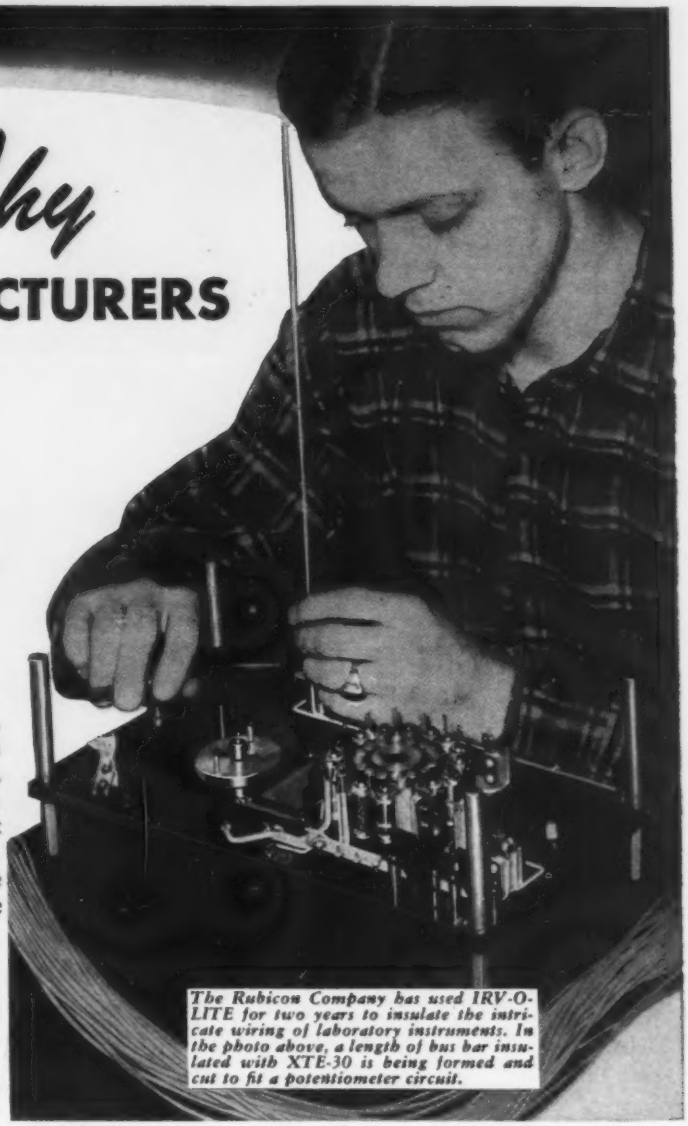
Provisions for using the Gordon envelopes with suitable light sources have been incorporated in a new bomber which is now in production, and the system is already being used by the Signal Corps.

The Gordon portable light source, designed especially for use with fluorescent plastic envelopes, is a self-contained 2½-w. near-ultraviolet lamp with batteries. It can be used either on a table or placed on the forehead like a miner's lamp. The 4-w., 24 to 28-v. black light source standardized by both the Army and Navy will permit vision over an area of 39 square inches of fluorescent envelope material when held five inches above the surface.

Here's Why

ELECTRICAL MANUFACTURERS *buy*

IRV-O-LITE XTE-30



The Rubicon Company has used IRV-O-LITE for two years to insulate the intricate wiring of laboratory instruments. In the photo above, a length of bus bar insulated with XTE-30 is being formed and cut to fit a potentiometer circuit.

Whether used as wiring or lug insulation or as conduit, this extruded plastic tubing will do a good job even under difficult conditions. It has been employed on tiny, fractional horsepower motors and on giant aircraft; in the construction of sensitive laboratory equipment and in rough-riding Army tanks.

IRV-O-LITE XTE-30 is suitable for such diverse installations because random samples consistently live up to these standards:

Dry Dielectric Strength	750 VPM
Wet Dielectric Strength	350 VPM
Tensile Strength Lbs. per Sq. In.	2,150
Elongation	250%
Resistance to Brittleness. Standard wall XTE tubing does not shatter when slowly pinched with pliers at	—40 deg. F.
Life at 105° C.	400 hrs.
Wemco Oil Immersion 48 hrs. at 100° C. Intact, can be flexed	
Resistance to 50% Sulphuric Acid at 72° F.	Unaffected
Resistance to 30% Sodium Hydroxide at 72° F.	Unaffected
Resistance to Mineral Solvents	Excellent
Resistance to Coal Tar Solvents	Good

In addition to being unusually flexible and elastic over a wide range of temperatures, XTE-30 tubing is also highly resistant to tearing and abrasion.

IRV-O-LITE XTE-30 is produced in sizes ranging from A.S.T.M. No. 24 to 1½" I.D. and in six opaque colors, black, green, white, yellow, red and blue, to simplify identification of circuits. Standard lengths are 36-inch pieces and 25-ft. coils. Continuous length coils and cut pieces from ¼" to 12" can also be furnished.

NEW! Most recent addition to the Irvington Fibronized tubing line, XTE-130 was developed to withstand unusually high temperatures. Samples of No. 9 opaque have yielded an oven life of 500 hrs. at 125° C. (257° F.), 1000 hrs. at 105° C. (221° F.).

IRV-O-LITE XTE-130 offers a dielectric strength of 1000 VPM both wet and dry, tensile strength of 4000 lbs. per sq. in. Although slightly less flexible than XTE-30 at room temperature, this tubing resembles it in other respects. XTE-130 is obtainable in black, green, white, yellow, red, blue and clear, in A.S.T.M. sizes No. 20 to 1½" I.D. and same lengths given above.

For additional information or for testing samples write Dept.

Over 25,000,000 feet of IRV-O-LITE now serving industry

Irvington

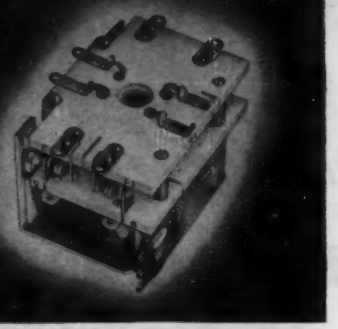
STANDARD OF THE WORLD
IRVINGTON INSULATION
TRADE REG. U. S. PAT. OFF. MARK

VARNISH & INSULATOR CO.

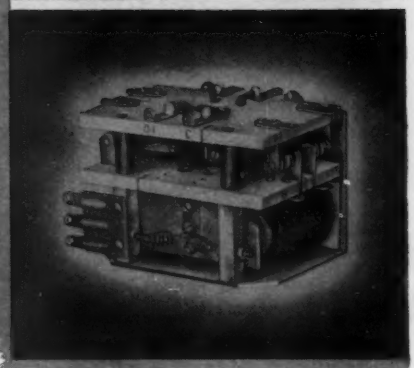
Representatives in 20 Principal Cities

IRVINGTON, NEW JERSEY, U. S. A. • PLANTS AT: IRVINGTON, NEW JERSEY & HAMILTON, ONTARIO, CANADA

ALLIED CONTROL COMPANY, INC.



AK HIGH-SPEED
KEYING
BREAK-IN
RELAY



Completely balanced... arms equipped with anti-bounce features

Magnetically held in both positions..does not rely on back spring pressure

Insulation plates of high pressure Steatite

Mounting features with elastic stop nuts

Keys at 20 cycles per second

All terminals easily accessible

Contact rating 1,000 volts at 30,000 feet..20 megacycles ..4 pole double throw

Wattage consumption 5.5 in first position .. 17.0 in second position

Withstands vibration to better than 20 G

Insulated to sustain 10,000 volts at sea level

Dimensions 2-7/16 x 3½ x 2¼

● AK a compact, high voltage, high speed, anti-vibration type keying relay for break-in operation in aircraft radio equipment. A push-pull magnetic arrangement which provides magnetic holding pressure on both transmit and receive contacts. One pole is equipped with two windings, one of which is a holding winding connected directly across the battery supply. The other winding is connected in series with the single winding on the other pole and polarized so that when the circuit is completed through the key, the flux is neutralized on the holding or receive position pole and the armature pulls up to the transmit position. Opening the key cuts off the bucking flux and the holding flux pulls armature back to receive position.

ALLIED CONTROL COMPANY, INC.

227 FULTON ST., NEW YORK

Factories

NEW YORK CITY • LONG ISLAND CITY

CHICAGO • PLANTSVILLE, CONN.

Raised Dots on Gage Dial Permit Inspection by Blind Workers

PRECISION INSPECTION of parts by blind persons to check conformance with permissible tolerance limits is possible with an instrument manufactured by Trico Products Corp., Buffalo, N. Y. The fixed tolerance markings are raised above the face of the dial, and the conventional gaging indicator is replaced with a simple vertical pointer to permit finger-touch readings with an accuracy as good as one ten-thousandth inch in some cases.

• • •

Electronics Guards the Mint

METAL MONEY minted by the United States Government at a place which shall remain un-named is marked with a substance which is invisible to the naked-eye under ordinary light but quite visible when exposed to ultraviolet light. Ultraviolet lamps blanket all exits and entrances so coins so marked are readily identified as the property of Uncle Sam if anyone accidentally or otherwise attempts to carry out "samples."

• • •

MASTER RADIO

Warden Clinton Duffy of San Quentin prison is shown inspecting the master radio receiver which has been installed outside prison walls. This unit will serve four thousand sets of earphones installed in cells where prisoners have earned special privileges. Warden Duffy will conduct his own program for ten minutes each week. The program is entitled "Man to Man" which discusses prison problems for listening inmates

NOT TWINS . . . triplets . . . quintuplets—but *billionettes*, each the "spittin' image" of the one that preceded. That is the rigid uniformity required of American arms and ammunition, a requirement which demands all the "deadly precision" industry can develop.

Maintenance of production schedules and uniform accuracy in products is a difficult assignment these days. Overloaded supply lines deliver unreliable power voltages. During periods of peak loads, voltages may vary as much as 30%. Unexpected surges cause unsteady operation of precision machines and irreparable damage to delicate instruments and tubes.

Sola Constant Voltage transformers automatically correct these voltage fluctuations. Regardless of variation in line supply, they deliver an unerring, specific voltage that makes precision performance a reality. They are instantaneous in action—have no moving parts and are self-protecting against short circuit. Standard units available for all ordinary applications, or specialized units to meet unusual requirements.

Note to Industrial Executives: *The problems solved by Sola "CV" transformers in other plants may have an exact counterpart in yours. Find out. Ask for bulletin DCV-74*

SOLA
Constant Voltage Transformers

Transformers for: Constant Voltage • Cold Cathode Lighting • Mercury Lamps • Series Lighting • Fluorescent Lighting • X-ray Equipment • Luminous Tube Signs Oil Burner Ignition • Radio • Power • Controls • Signal Systems • Door Bells and Chimes • etc. **SOLA ELECTRIC CO., 2525 Clybourn Ave., Chicago, Ill.**

ENGINEERED TO LICK SEVERE HEAT AND HUMIDITY PROBLEMS

Thermador Transformers are Thermatite treated to withstand extreme temperatures and humidity—arid or moist heat—dry or damp cold do not hamper their efficiency Thermatite is the name of a process of accurate heat controlled vacuum impregnation developed and improved over a period of ten years.

THERMADOR
THERMATITE TREATED
TRANSFORMER

THE THERMADOR TRANSFORMER LINE
Included in the Thermador Transformer line are audio, auto, geophysical, bias supply, briding, cathode modulation, coupling, driver, field supply, filament, high fidelity audio, input, midget plug-in audio, mixing and matching, modulation, output, plate, power, television, and tube-to-line transformers. Filters, chokes, and reactors.
ARMY E NAVY

THERMADOR ELECTRICAL MFG. COMPANY
5119 South Riverside Drive, Los Angeles, Calif.
"Seven Leagues Ahead"

NEW BOOKS

The Theory of the Photographic Process

By C. E. KENNETH MEES, *D. Sc., F. R. S. Vice President in Charge of Research and Development. Eastman Kodak Company. The MacMillan Company, New York, 1942, 1124 pages. Price $15.50.*

A MEMBER of a large research organization in need of specific information for the job at hand has only to get in touch with some other member, a specialist, who can tell him what he wants to know or who can tell him just where to get the needed information. For a solo worker or member of a small group, such access is not possible. The investigator is then saddled with the additional problem of trying to find out where to look for the required data.

This problem of where to find reliable facts is especially real for the worker in photography. The present book by Dr. Mees goes a long way towards bridging this difficulty.

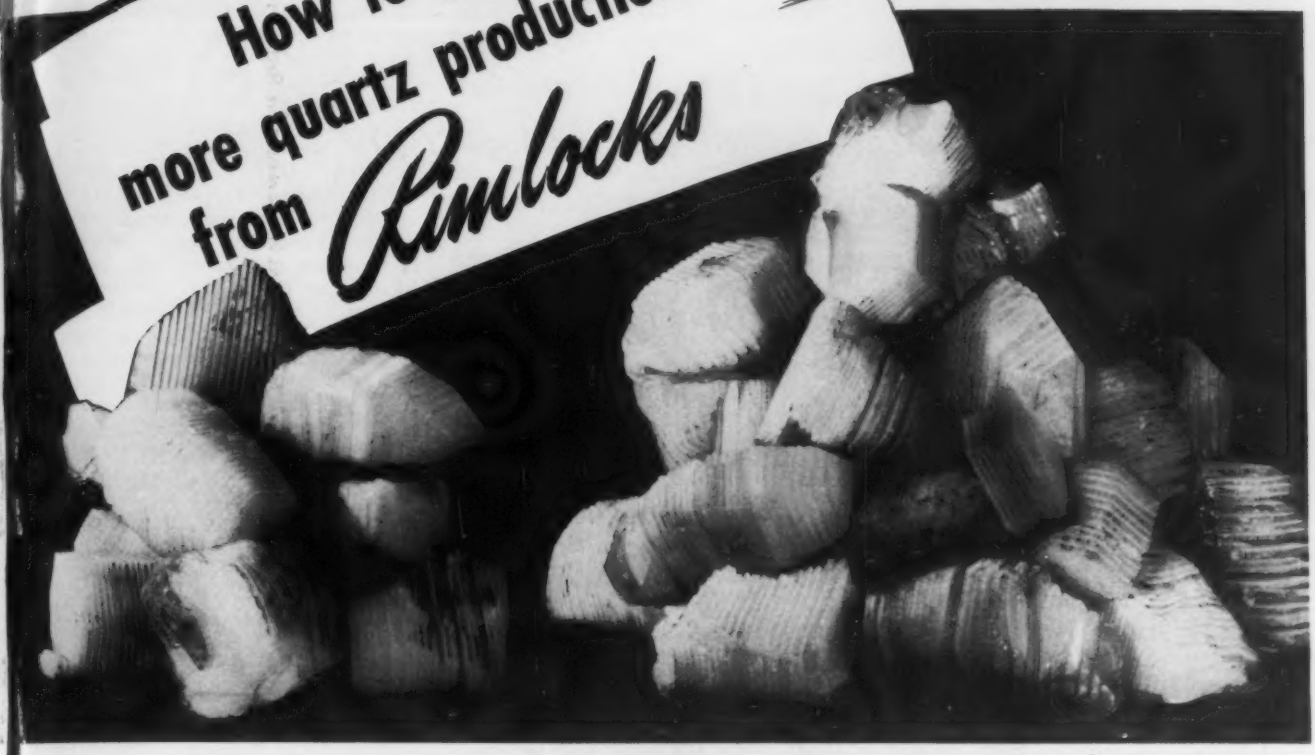
"During the last fifty years, scientific workers interested in the study of the photographic process have built up a fund of knowledge which is scattered through the literature in several languages and in a great diversity of journals. The purpose of this book is to provide a general handbook of the subject as a guide to the literature and as a summary of its conclusions."

This is not a book for the amateur who is dissatisfied with the prints supplied by the corner drug store and has decided to start doing his own darkroom work. It is rather for the serious scientific worker confronted by some unexpected or unfamiliar photographic reaction for which an explanation or by-pass is required, or for one who wishes to become familiar with the present state of the art and its past history before launching into the unknown.

The book is divided into six parts preceded by a one page Introduction outlining the operations involved in the photographic process. The sections cover: The Photographic Material, The Action of Light, Development and the After Processes, Sensitometry, Photographic Physics and Optical Sensitizing. Each chapter, of which there are twenty-five in all, follows the same plan of presentation as that used in the Introduction, in that the opening paragraph briefly and simply outlines the subject matter of that chapter. Then follow the important highlights of the subject in the past and the results of recent research. Copious references are given to original sources in the literature and frequent results of unpublished research are made available. These are some of the chapter headings: The Preparation and Properties of Gelatin, The Reciprocity, Intermittency and Clayden Effects, The Kinetics of Development, The

FELKER DI-MET

How to get more quartz production from Rimlocks



Proper operation of DI-MET Rimlock quartz cutting wheels leads to greatly improved production, longer blade life . . . eliminates blade sharpening and gives better over-all results on all methods of cutting. Recommended procedures are simple, and resulting benefits are well worth the effort.

OBSERVE these four major rules in your quartz cutting operations and you'll get more satisfaction than ever before from fast-cutting Rimlocks!

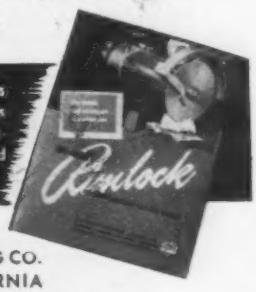
Operate Rimlocks at the correct speed! Surface speed should range from 4000 to 4500 s.f.m., which is an r.p.m. of approximately 2000 for an 8" diameter Rimlock.

Keep the feed pressure light! A load of 7 lbs. is ample. Too much pressure shortens blade life . . . drives diamonds back into the metal and turns them sideways, destroying the fast, free cutting action.

Use abundant coolant of rich mixture! A mineral base soluble oil mixed in a ratio of 4 parts water to 1 part oil provides very satisfactory lubrication with efficient cooling ability. Flood both sides of blade generously.

Use ample motor power! Variation of blade r.p.m. during cutting operations lowers blade efficiency, dulls cutting edges and destroys accuracy. A ¾ h.p. motor is recommended for general quartz cutting operations.

Have you received your free copy of this new Rimlock folder? It provides many hints on proper Rimlock operation that may improve your quartz production. Fill in and mail this coupon today!



FELKER MANUFACTURING CO.
TORRANCE, CALIFORNIA

Please send me the new Rimlock folder.

Name_____

Title_____

Company_____

Address_____

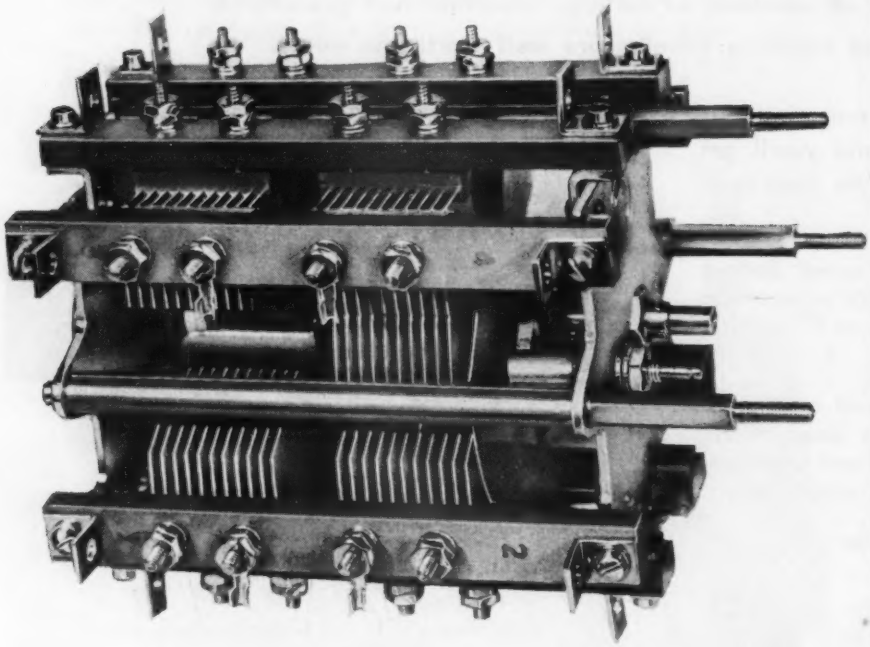
FELKER MANUFACTURING CO.
1116 BORDER ST., TORRANCE, CALIFORNIA

MANUFACTURERS OF DIAMOND ABRASIVE WHEELS

Those things we haven't mentioned

Frankly, there's a great deal going on at Cardwell that we haven't mentioned in our ads. We can't catalogue our new and improved equipment, nor can we promise it for civilian application at any definite future time, since only orders bearing the very highest priority ratings can be accepted.

We can, however, pledge an even better Cardwell product for your eventual use. Design refinements in existing models, developments in standard condenser types and radically new features are incorporated in the present Cardwell line. The experience of the men who pioneered the original metal end plate capacitors makes Cardwell, as always, a standard of comparison.



CARDWELL CONDENSERS

THE ALLEN D. CARDWELL MANUFACTURING CORPORATION BROOKLYN, NEW YORK

Measurement of Spectral Sensitivity Photographic Aspects of Sound Recording and The Mechanism of Optical Sensitizing. Chapter 20 on Tone Reproduction should be of particular interest to those working on television.

The author acknowledges the generous assistance received from many of his co-workers at Kodak Park in the preparation of the book. Several have contributed whole chapters while others have assisted in the revision of chapters. The dedication "To Samuel E. Sheppard, D. Sc., in recognition of a collaboration in research on the theory of the photographic process, which has continued for forty years," is a particularly happy one, for it will be remembered that Mees' and Sheppard's "Investigations on the Theory of the Photographic Process," published in 1907 contained the material of theses accepted from these men for the degrees of Bachelor of Science and Doctor of Science.

The book runs to 1124 pages, lists 150 scientific journals and 946 authors, has 89 tables, 406 illustrations besides numerous chemical diagrams, gives 1750 references to the literature, has a complete subject index, weighs 4 pounds and costs $12.50.—W.G.H.

• • •

Principles of Electronics

By ROYCE G. KLOEFFLER, *Professor of Electrical Engineering, Kansas State College. John Wiley & Sons, Inc. 1942. 175 pages. Price $2.50.*

THIS ADDITION to the steadily growing list of books on electronics is suitable for a short introductory course in the subject, and in fact has been written from the author's own teaching. In his case, sophomore students in electrical engineering have had this course for some 12 years.

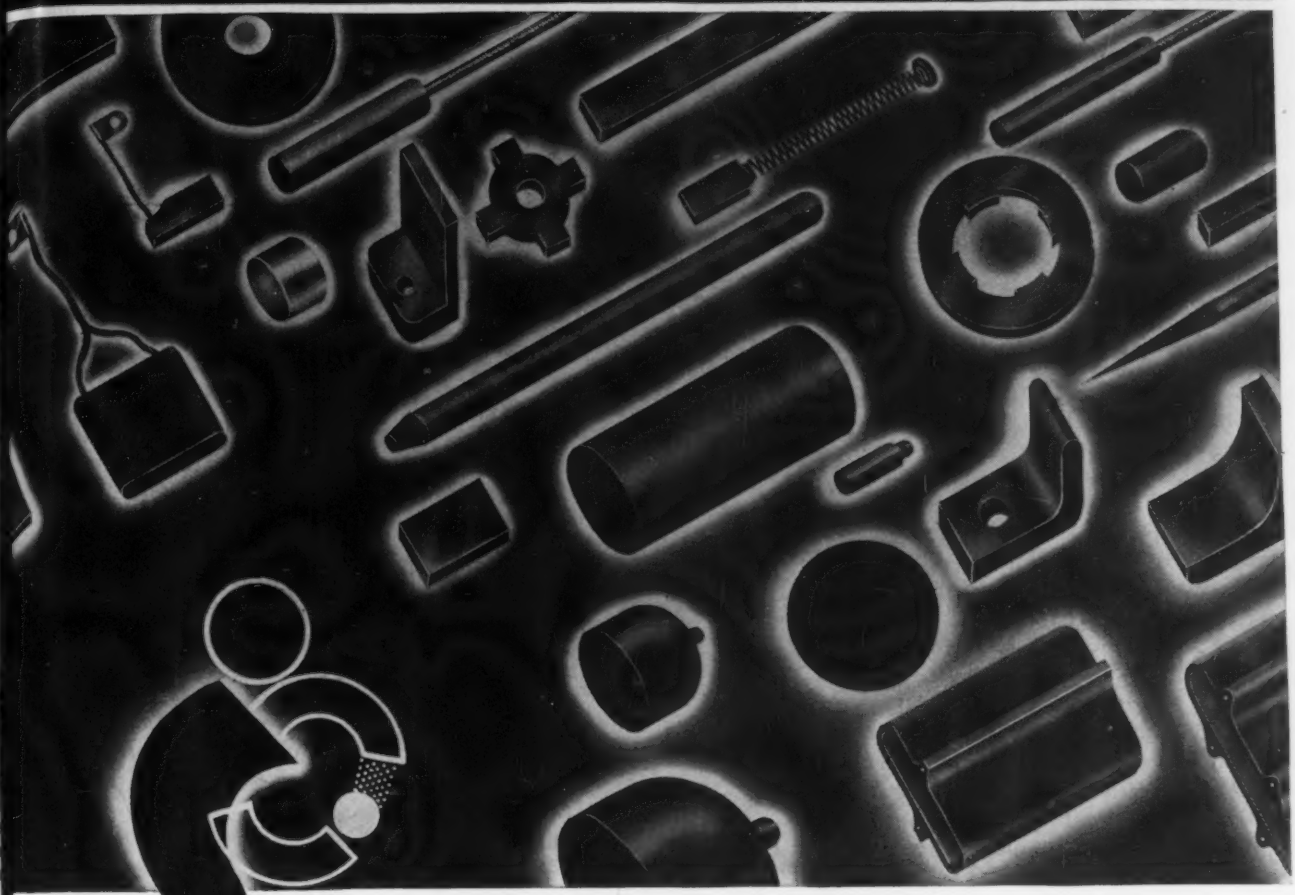
The author conceives the teaching of electrical engineering as having two possibilities; one is the old-fashioned method of indoctrinating the student with electric and magnetic circuits followed by a study of power machinery. Another way to start the student on his way to being an electrical engineer is to teach him electronics right off the bat. The author feels that the "extreme simplicity of action taking place in the electron tube justifies this approach."

While this book deals with the "principles" it is not "elementary." The first chapter gives a quick history of our knowledge of electricity, from Gilbert, to Franklin, to Faraday, Maxwell and Stoney. The second and succeeding chapters cover the electron, the atom, gaseous conduction, electron emission, two- three- and four-electrode tubes, then rectifying devices, photoelectric devices, and a final chapter on typical applications of electron tubes.

The great virtue of this book is that it is short, and not filled with great quantities of detail which must only confuse and bewilder the first comer to the field of electronics.—K.H.

Additional Book Reviews will be found on page 208.

SOLIDS FROM POWDERS *in 30 seconds!*



...TO HELP SOLVE DESIGN, PRODUCTION AND PRIORITY MATERIAL PROBLEMS

Typical Stackpole Molded Products

- Brushes and Contacts (*all carbon, graphite, metal and composition types*)
- Rare Metal Contacts
- Powdered Iron Components
- Anodes
- Electrodes
- Brazing Blocks
- Bearings
- Welding Rods, Electrodes, and Plates
- Pipe
- Packing, Piston and Seal Rings
- Rheostat Plates and Discs
- Brake Lining, *and numerous others*

Stackpole Electronic Products

- Fixed and Variable Resistors
- Switches
- Molded Iron Cores

Outstanding among current developments is the rapid increase in the use of solids molded from powders. Not only do these include the better-known types of carbon, carbon graphite and similar compositions but, of steadily growing importance, are the countless parts formed from molded iron and iron-nickel powders. Savings in machining operations, faster production, and the frequent ability to utilize less critical materials are outstanding among the advantages involved.

As a leader for over a third of a century in the molding of solids from powders, it is only natural that Stackpole today should be headquarters for the latest developments—whether they entail powder iron metallurgy, or the forming of rare metal contacts from powders, a field in which Stackpole developments have set new standards of performance.

A vast fund of accumulated engineering knowledge backed by exclusive processes is here available to manufacturers whose products may be made better or produced faster by the use of molded carbon, iron, or rare metal components.

STACKPOLE CARBON COMPANY, *St. Marys, Penna.*

STACKPOLE

MOLDED CARBON AND METAL PRODUCTS

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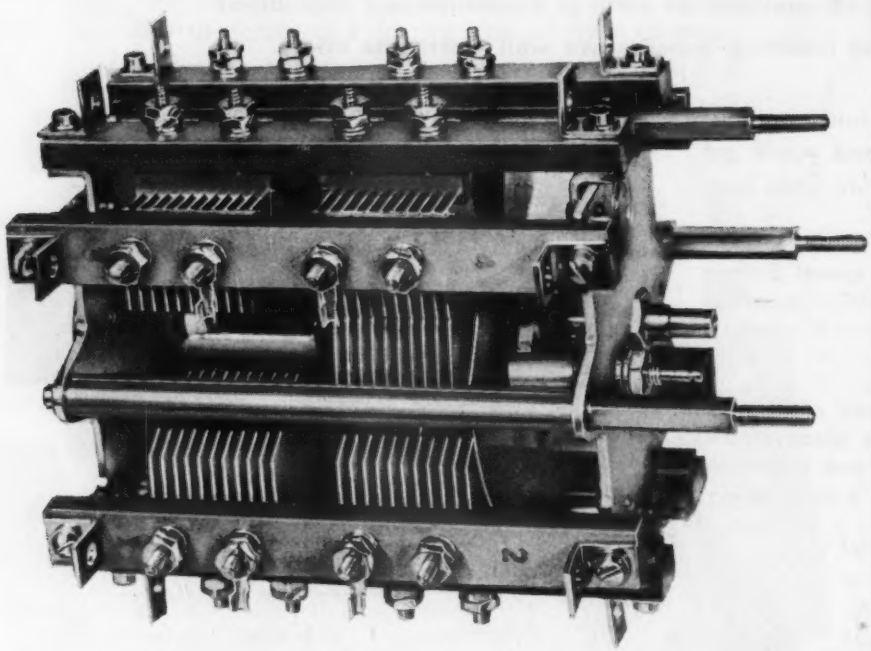

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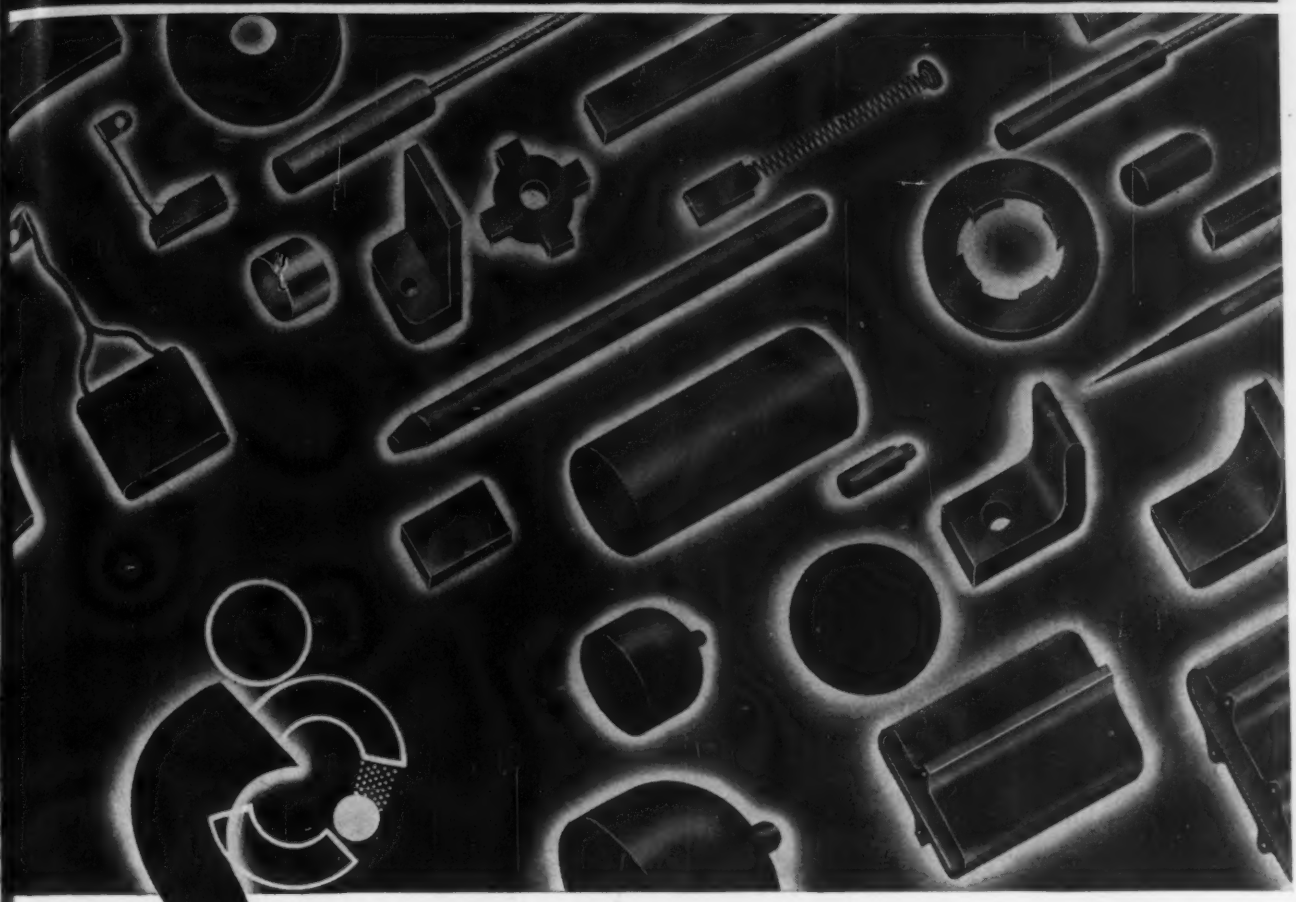

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STACKPOLE CARBON COMPANY, *St. Marys, Penna.*

STACKPOLE

MOLDED CARBON AND METAL PRODUCTS

THE ELECTRON ART

Rediffusion 126
A New and Stable Frequency Divider 126
Stabilized Oscillator 130
Standards on Graphical Symbols for Communication Use 134
Electron Microscope Applied to Insect Study 134
Performance Curve for m-Derive Filters 136
Submarine Communication 136
Element 85 Located 138

Rediffusion

THE ADVANTAGES offered by rediffusion for wire transmission of programs, particularly as this development has been practiced in England, is described by Paul Adorjan in the October, 1942 issue of *Endeavor*, a comparatively new British publication on various aspects of science, and published in London.

Mr. Adorjan points out that the means of distributing speech and music to a wide audience is traceable to the first development of the telephone. However, the limited practical means available in the 80's and 90's, together with the inadequate support received by such systems made distribution of entertainment or educational programs of little commercial success.

Not until broadcasting became possible and the many technical developments with which broadcasting is associated became available, was it possible to develop any means of rediffusion with hopes of commercial success.

In England various methods of distribution of broadcast programs over wires are known by the name of rediffusion. Simply, the main groups under which rediffusion systems can be classified are as follows:

(1) Radio frequency rediffusion.
  On existing networks.
  On special networks.
(2) Audio frequency rediffusion.
  On existing networks.
  On special networks auxiliary to existing networks.
  On special networks.

The distribution of programs at audio frequencies over special networks erected for the purpose has been a method which has found greatest application in England, and it is the only one which has been used successfully in practice. The success of this system is largely attributable to the simplicity of the scheme, combined with the fact that it can be operated satisfactorily on an economic basis and still give excellent results. For such a system, it is only necessary that the subscriber be provided with a suitable program selector switch, a loudspeaker and a volume control.

Mr. Adorjan points out that at the time of writing the article (presumably in the summer of 1942) there were about 400,000 homes in Great Britain obtaining their radio programs by means of rediffusion. This comparatively small number, contrasted with the number of radio licenses which are issued, is explained by the difficulty which has confronted those concerns which have attempted to establish rediffusion systems, and particularly the short term of the licenses for such systems. Recently the license for rediffusion companies has been extended to ten years. It might be anticipated, therefore, that except for the war, a considerable increase in rediffusion systems should be expected.

It has been customary to distribute programs from the amplifying stage (whose amplifiers are capable of delivering between 100 and 1,500 watts of undistorted power output) by means of high voltage lines to numerous transformer kiosks at which the voltage is stepped down to a suitable level for reception. From the transformer boxes, distribution feeders bring programs to the subscriber's premises.

Advantages claimed for the audio frequency rediffusion system using special networks may be summarized as follows:

(1) There is no frequency discrimination, harmonic distortion, or noise due to the radio transmitter. Additional line amplifiers introduce only negligible noise and distortion.

(2) So far as the transmitting medium is concerned there is no fading interference from other transmitters, or electrical interference. Line noise and distortion may be kept to a negligible value.

(3) No frequency discrimination exists as a result of receiver selectivity.

(4) The frequency discrimination introduced by rediffusion feeders is small compared with that introduced by the usual radio receiver.

(5) There is no second channel interference, tube noise or harmonic distortion resulting from the use of radio receivers.

In view of the great advantages of wire over radio, particularly for the distribution of broadcast programs in densely populated areas, the author concludes, there can be little doubt that this method will be employed in an increasing proportion of homes. There is, moreover, no technical reason why it should not be used in the future for distribution of broadcast programs in rural areas.

A New and Stable Frequency Divider

THE USE OF A single frequency, highly stabilized oscillator, to provide a multiplicity of standardized frequencies from a single source has become general practice in many laboratories. The construction and maintenance of a highly stable oscillator is not too difficult of accomplishment unless extremely high precision is required. Nevertheless, the means by which frequency multiples or sub-multiples of the fundamental frequency may be derived from a given oscillator have been a source of some difficulty. In many cases multivibrators have been employed to provide frequency division. Such multivibrators must, of themselves, act as oscillators and are only effective as frequency dividers by being controlled by the master oscillator. Should the output from the master oscillator fail, the multivibrators would provide an unstabilized output which, in most cases is undesired.

A new frequency dividing circuit

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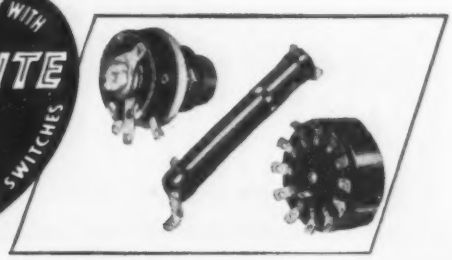
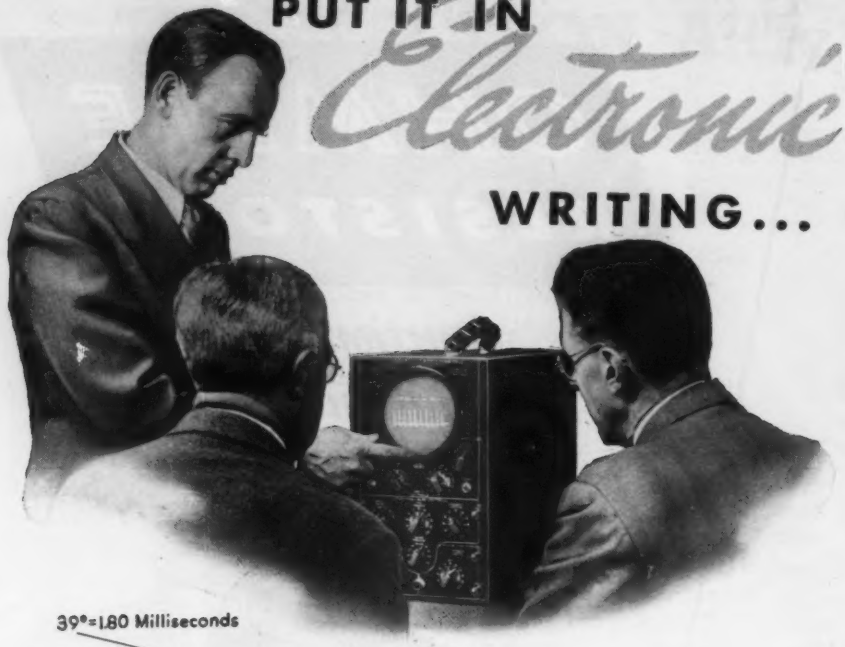
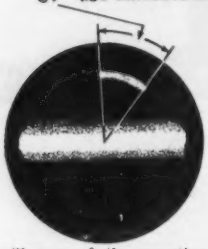


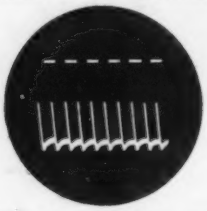
PUT IT IN *Electronic* WRITING...



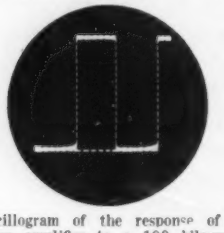
39°=1.80 Milliseconds



Oscillogram of the operation of a two-way snap-switch, accurately timed in milliseconds. The segment represented by the curved trace or arc, measures 39°, or the equivalent of 1.8 millisecond.



Oscillogram showing the precise wave form of the DuMont Variable-Frequency Stimulator for brain surgery and research. The remarkable uniformity of wave form and amplitude of the stimuli, is clearly disclosed here. Time interval: 1 millisecond.



Oscillogram of the response of a given amplifier to a 100 kilocycle square-wave signal. Such electronic writing provides the best evidence of actual performance.

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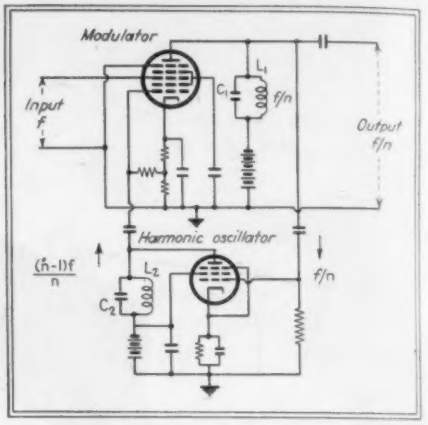
which has several advantages over the multivibrator is described by F. R. Stansel in the December issue of the *Bell Laboratories Record*. Essentially the frequency divider of improved form consists of a modulator, an output circuit tuned to the sub-multiple frequency desired, and a harmonic generator. The waveform of such a frequency divider is much more nearly sinusoidal than that of the multivibrator. Moreover, unlike the multivibrator, the frequency generator cannot operate without an input frequency. Should the input frequency fail, the output drops to zero, and thus off frequency operation does not occur. In addition, the output current of the generator is a relatively pure sine wave.



Schematic wiring diagram of frequency divider producing relatively pure sinusoidal output and which fails to operate unless voltage is applied to grid of modulator

The input voltage, whose frequency is stabilized and controlled, is fed to two grids of a pentagrid-mixer tube, acting as a modulator. The tuned circuit in the plate of the modulator tube, L_1C_1 is made resonant to the desired frequency sub-multiple. Thus, if f is the frequency of the input voltage, and this frequency is to be divided by some integer, n, then the circuit L_1C_1 is made resonant to f/n, which will also be the frequency of the output voltage.

It will be observed that voltage of the desired output frequency is fed to the control grid of the harmonic oscillator. The resonant circuit L_2C_2 in the plate circuit of this tube is tuned to a frequency $(n\text{-}1)\ f/n$, and the output voltage of this frequency is in turn fed to the No. 1 grid of the pentagrid-mixer tube or modulator.

It is now evident that, once the

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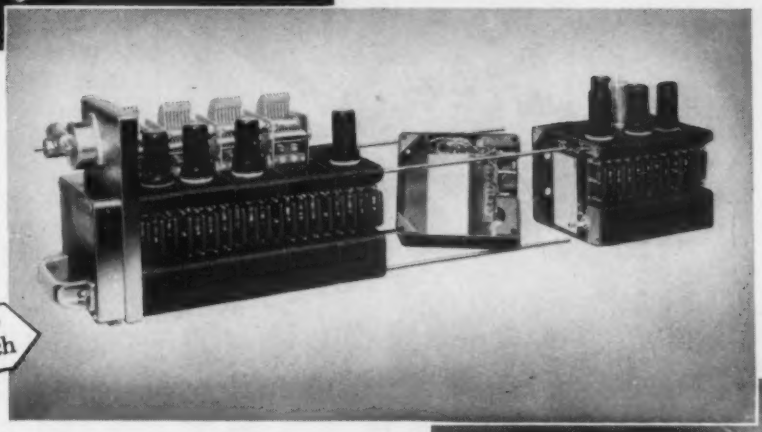
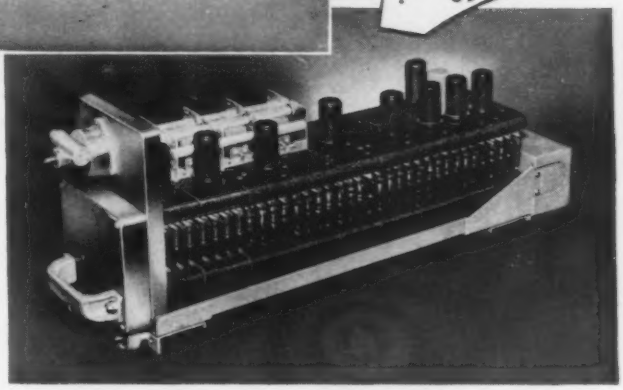


. . . on the service bench



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Replacement of circuit-element cells in Harvey Receivers is as easy as changing a tube

The revolutionary cell-unit construction developed by Harvey engineers not only speeds production, but *greatly* simplifies servicing. Instead of requiring complicated circuit diagrams, scores of special parts, solder, and an expert serviceman—when repairs are necessary—the entire circuit element is replaced in a matter of minutes.

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circuit is started, the modulator tube is fed with frequencies of f and $(n\text{-}1)\ f/n$. Since the oscillator operates as a non-linear device, the output circuit will normally contain the sum and difference of the frequencies applied to its grids. The difference between the two frequencies is the desired output frequency, and the plate circuit of the modulator is tuned to this value as explained previously.

The only difficulty in explaining the behavior of a circuit of this type is to introduce some means of dividing a frequency of the desired value in the plate circuit of the modulator tube. Experience has shown that the transient set up when the circuit is first put into operation contains a sufficient amplitude of voltage of the desired frequency for the circuit to launch into operation and trigger off, after which it operates in a manner already described.

While the frequency divider circuit shown is somewhat more complicated than the usual multivibrator, it does not require any more tubes than a multivibrator, fails to operate if the stabilized voltage fails, and produces much better waveform. For this reason it has been quite extensively used to replace multivibrators.

• • •

Stabilized Oscillator

A STABILIZED VACUUM tube oscillator due to F. E. Terman is shown in schematic form in the accompanying illustration. The circuit may be looked upon as being derived from the shunt feed, tuned plate oscillator, although several additional features have been incorporated. One of these is the use of a feedback stabilizing circuit of the type originally described by J. W. Horton and incorporating the resistor R_1. Another innovation of the circuit is the means of providing negative feedback by means of the resistor R_2 and an automatic grid bias by means of the resistor R_3 and the condenser C_3. The most novel feature of the circuit, however, is the inclusion of a diode rectifier with delayed biasing voltage as shown at the left of the diagram.

Positive feedback from the plate of the oscillator tube VT_2 is fed to the tuned circuit L_1C_1, through the series resistor R_1. The voltage in

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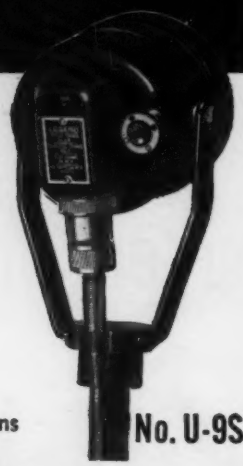

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this circuit is induced in the gr coil L_2 by means of the mutual i ductance, M. The frequency of osc lation is determined, in the cu tomary manner, by the circuit co stant L_1C_1.

The diode rectifier VT_1, in seri with the delay biasing battery, E, included to limit the amplitude the oscillation. A particular ad vantage arising from the use of separate tube for this purpose, that the amplitude limitation, de termined by the diode and th battery E, may be determined inde pendently of the characteristics VT_2 which may be most suitable fo oscillation. Accordingly, the ele trode voltages of the oscillator tub may be determined to operate on sensibly linear portion of the cha acteristics, and the limitation oscillation may be independentl controlled by the portion of the ci cuit at the extreme left of th diagram.

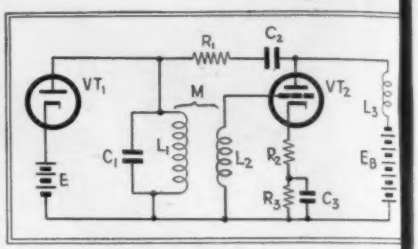
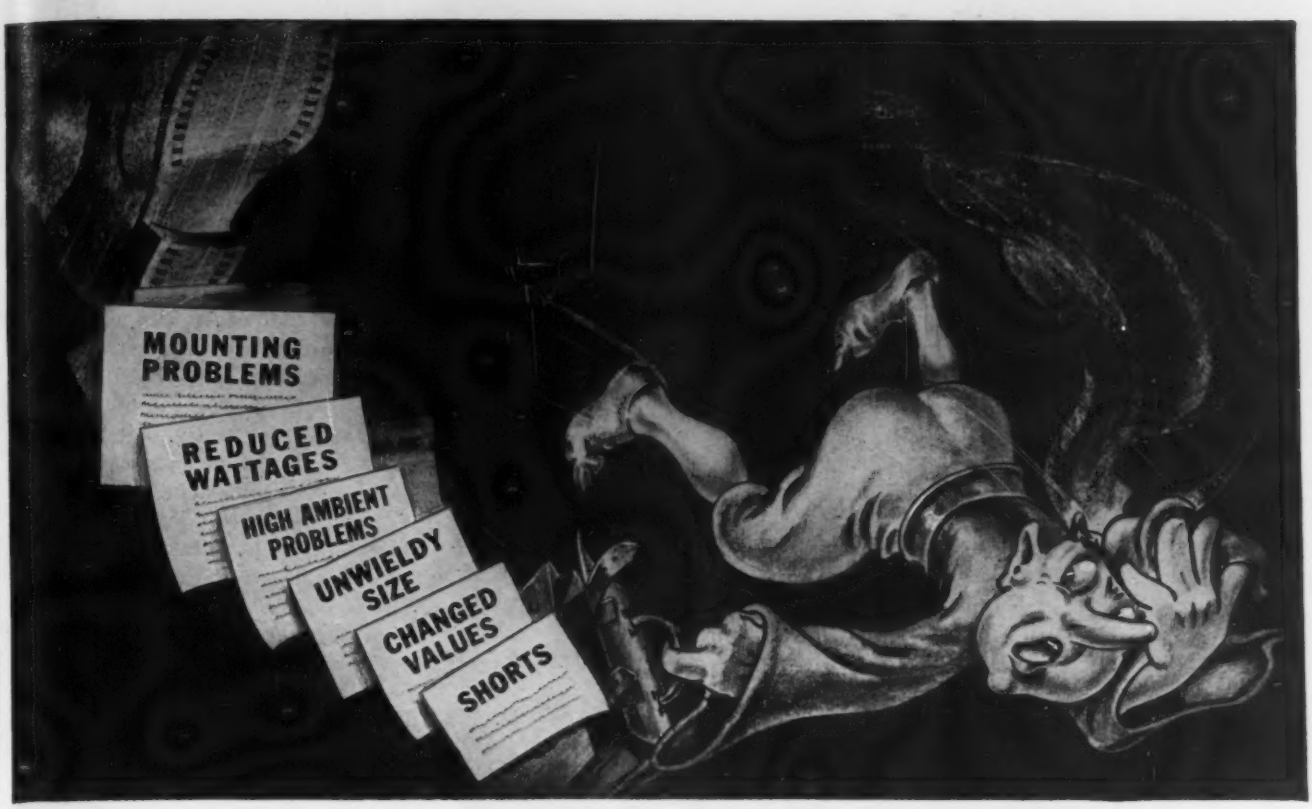


Diagram of oscillator whose amplitude o oscillation is limited by diode, VT_1

So long as the voltage across th tuned circuit does not exceed a pre determined value, the diode rectifie has no part in the circuit behavio except that it produces some capaci tance and some resistance acros L_1C_1. However, if the voltage acros the tuned circuit should exceed predetermined value, the diode be comes conductive and behaves some what as a short circuit across th tuned circuit, thereby limiting th amplitude of oscillation.

With a circuit arrangement o this type, sufficient flexibility i provided through the positive feed back through R_1 and M, the degener ative feedback through R_2 and th limiting action provided by th diode to produce a circuit of good waveform. In fact, the circuit ca be arranged so that the predominant portion of waveform distortion arises from the non-linear character istics of the triode.



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Goodbye to the many shortcomings common to conventional resistors space wound with bare wire and protected by brittle outer coatings! And good riddance!

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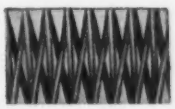

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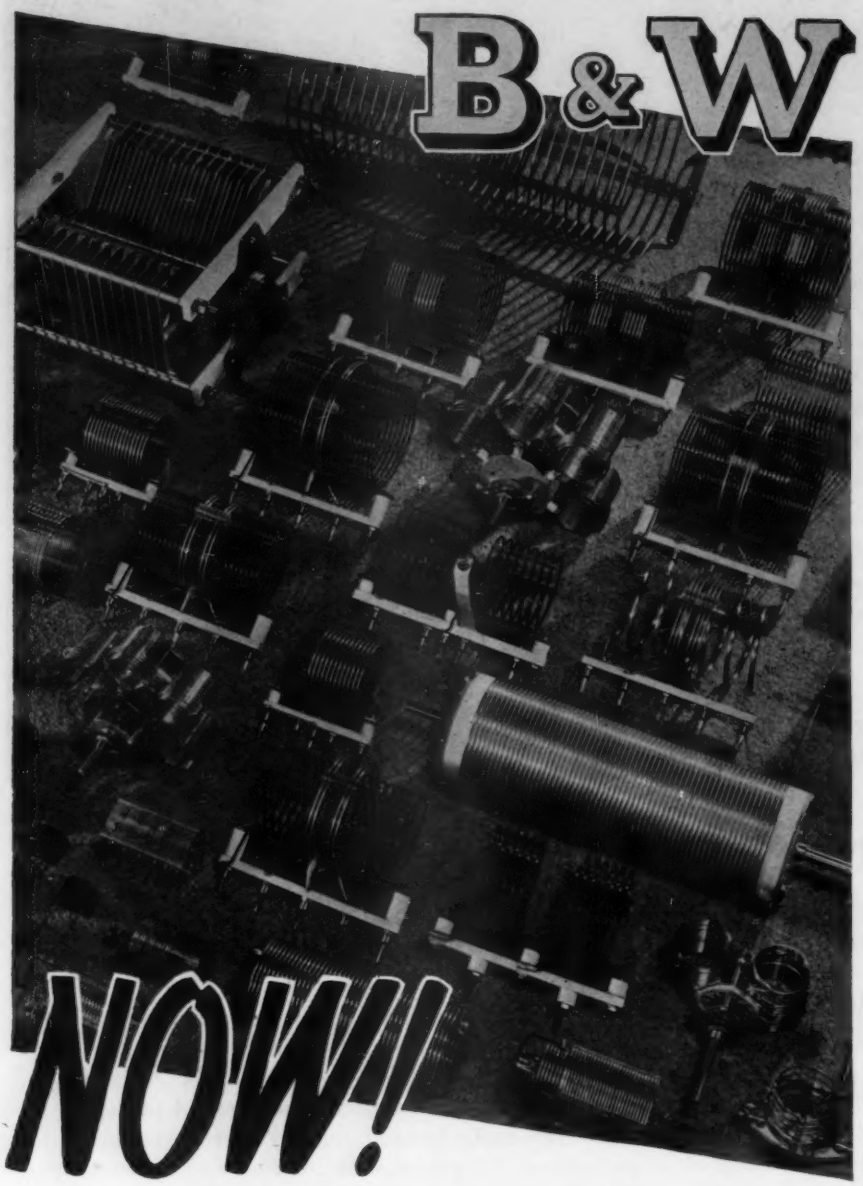

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Standards on Graphical Symbols for Communication Use

MORE THAN A DECADE ago tentative standard graphical symbols for radio use were established by the American Standards Association. These symbols have found rather widespread use in the communication field. However, the extension of communication equipment into the field of power, control and measurement, where other graphical symbols have frequently been used has resulted in some duplication, ambiguity and confusion. For this reason it appeared desirable to reexamine the tentative standards, and coordinate the symbols used in the communication field with those used in other fields, so far as it was possible.

As a result of coordinated effort along this direction, earlier standards of the American Standards Association have been revised and previous standards have been correlated into one unified field of endeavor.

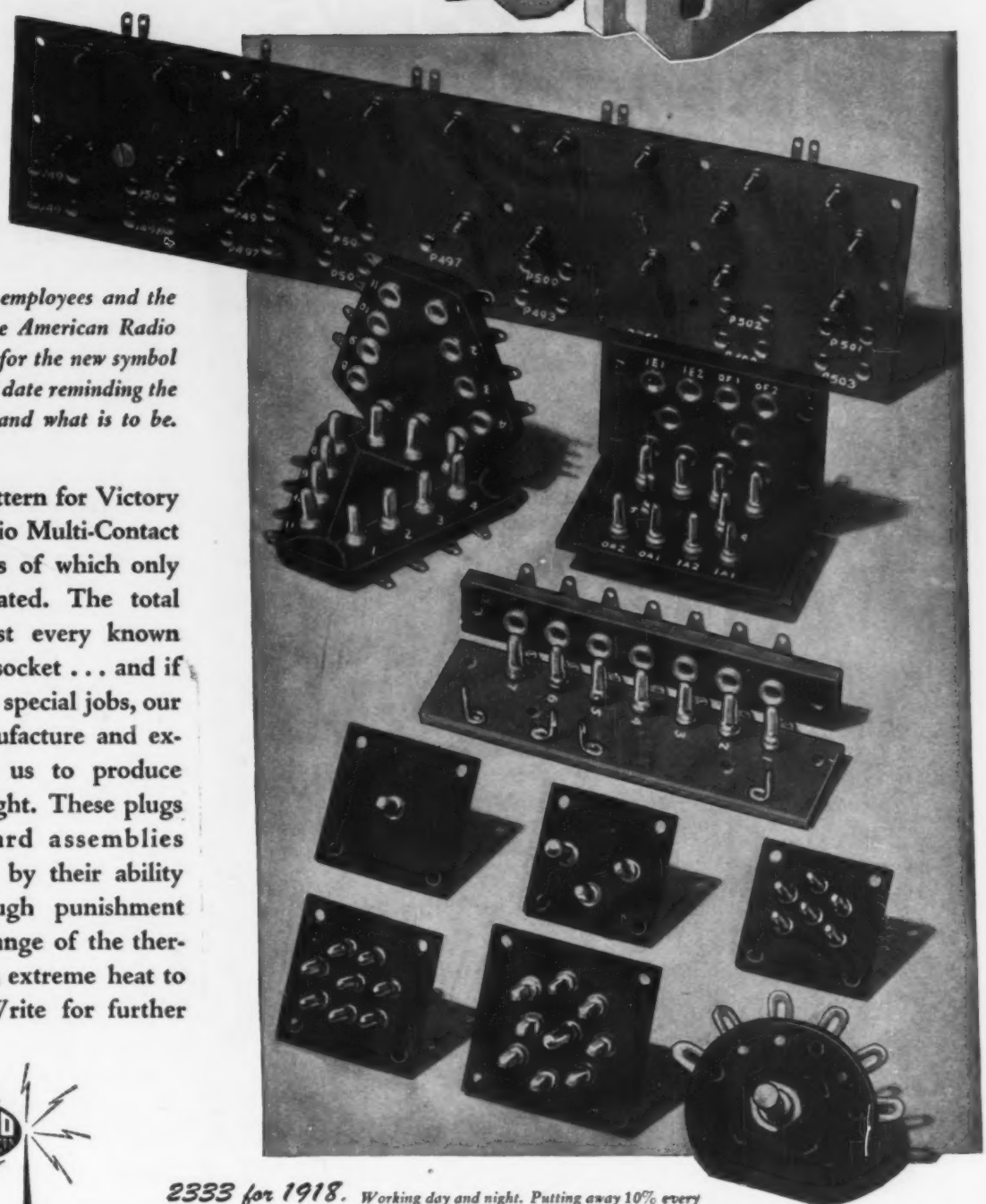
The new standards are available in a pamphlet entitled "Symbols for Telephone, Telegraph and Radio Use," designated as Standard Z 32.5-1942, available from the American Standards Association, 33 West 39th Street, New York City. This standard establishes basic symbols which may be built up as required for circuits of various degrees of complexity. It is anticipated that the publication and availability of these two standards will do much to eliminate the uncertainty which has arisen in the past concerning the proper use of such symbols. It should also go a long way toward producing uniform and consistent diagrams, now that there is so much activity in the communication field.

• • •

Electron Microscope Applied to Insect Study

THE ELECTRON MICROSCOPE has been used to study two types of structures responsible for the physical colors of insects. The work of this study is reported by Thomas F. Anderson and A. Glenn Richards, Jr., and is reported in the December issue of the *Journal of Applied Physics*. The two insects chosen for study were the brilliant blue tropi-

2333 FOR 1918



2333 for the 325 employees and the 2008 products of the American Radio Hardware Co. 1918 for the new symbol of Victory . . . fateful date reminding the enemy of what was and what is to be.

Partner in the pattern for Victory are American Radio Multi-Contact Plugs and Sockets of which only a few are illustrated. The total line covers almost every known type of plug and socket . . . and if the need arises for special jobs, our flexibility in manufacture and experience permits us to produce practically overnight. These plugs and socket board assemblies are characterized by their ability to withstand tough punishment over the entire range of the thermometer . . . from extreme heat to extreme cold. Write for further information.

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BEHIND today's war production at Murdock is 39 years of "know how"!

In 1904 William J. Murdock saw clearly that sensitive Radio Phones could be made only by precision methods. He manufactured each part with scientific exactness.

In each year since, requirements for Radio Phone sensitivity and durability have become increasingly strict. Murdock has kept pace.

Today the U. S. Army Signal Corps and Air Corps take most of our production. Murdock Radio Phones must be right to meet their specifications.

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cal butterfly, Morpho cypris and the iridiscent beetle Serica sericea.

It is shown that the iridiscence of the beetle is due to a line grating on its wing covers, 0.8 micron between lines. The structure giving rise to the brilliant blue color of the tropical butterfly is quite elaborate, consisting essentially of hundreds of vanes on each wing scale, the vanes possessing linear thickenings 0.2 micron apart, which reinforce the reflection of blue light. Numerous exceedingly fine markings on parts of the wing scale go down to 60 Angstroms and some of them may be related to the chemical structure of the scales.

• • •

Performance Curve for m-Derive Filters

A SERIES OF INTERESTING graphs showing the performance of low path m-derive wave filters is given by W. J. Cunningham in the December issue of the *Journal of Applied Physics*. All of the curves are experimentally determined for various types of filter configuration in which the filters were designed to have the cut-off frequency of 1,000 cps and designed for terminating resistance of 600 ohms. Dissipation of filter element is taken into account by virtue of the fact that coils used had a Q of about 50 and the condensers had a dissipation of about 0.005.

Fifteen different curves, corresponding to an equal number of different filter arrangements are plotted for various values of m.

The article contains a description of the method by which the experimental determination may be employed to design a filter having a specified characteristic. A particularly important application of the method of presenting this material is the fact that of a variety of filter structures employed, the most economical or the simplest filter structure which will accomplish the specifications may be selected.

• • •

Submarine Communication

THE BIBLIOGRAPHY on submarine communication, originally appearing in the July, 1942 issue of the *Broadcast Engineer's Journal*, has been reprinted in the December issue by popular request.

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Element 85 Is Isolated

THE DISCOVERY of a method of isolating chemical element 85 is announced jointly by two physicists at the Radium Institute of Bern—Dr. Walter Minder, director of the institute, and Dr. Alice Leigh-Smith, the first woman in England to receive a doctorate in nuclear physics. Element 85 is the last of the 92 primary components of matter to be isolated in an appreciable quantity and positively identified. It has been named anglo-helvetium by Dr. Leigh-Smith and Dr. Minder in honor of their respective countries.

The existence of element 85 had been postulated by other scientists for many years, and this element had been given the tentative name alabamine. In 1940, Dr. Minder announced that he had obtained an infinitesimal amount of 85 from radium, and he then called it simply helvetium. The present discovery is claimed to give enough material for photographic studies of spectral lines. Physicists and chemists will await further reports from these workers, as there is some reason to believe that element 85 is so unstable that it disintegrated long ago.

• • •

SALVAGED TREASURE

Members of the Marine communicators found this Japanese radio on Guadalcanal, they restored it to working order and now in their leisure hours they listen to U. S. broadcasts. Shown here are (left to right) Corp. James Shadduck, Pvt. Alex N. Incinelli, Pvt. Robert Galer, Corp. Sidney B. Land and Pvt. Arthur D. Roda. These are some of the men who see that the messages get through on Guadalcanal

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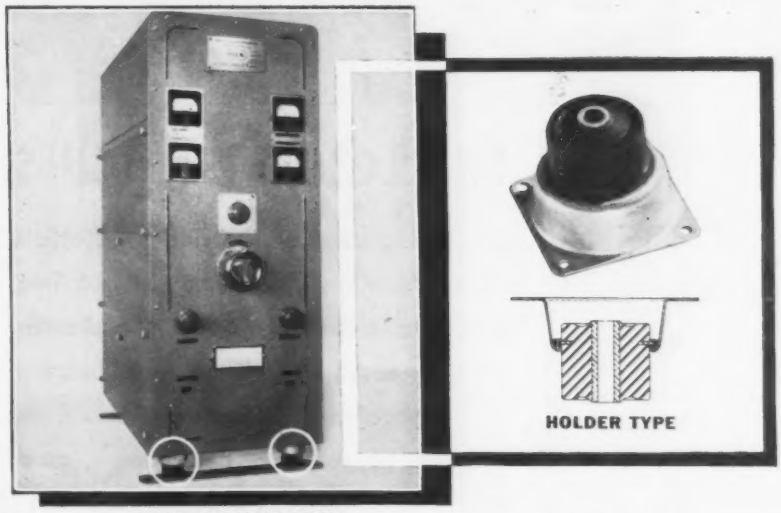

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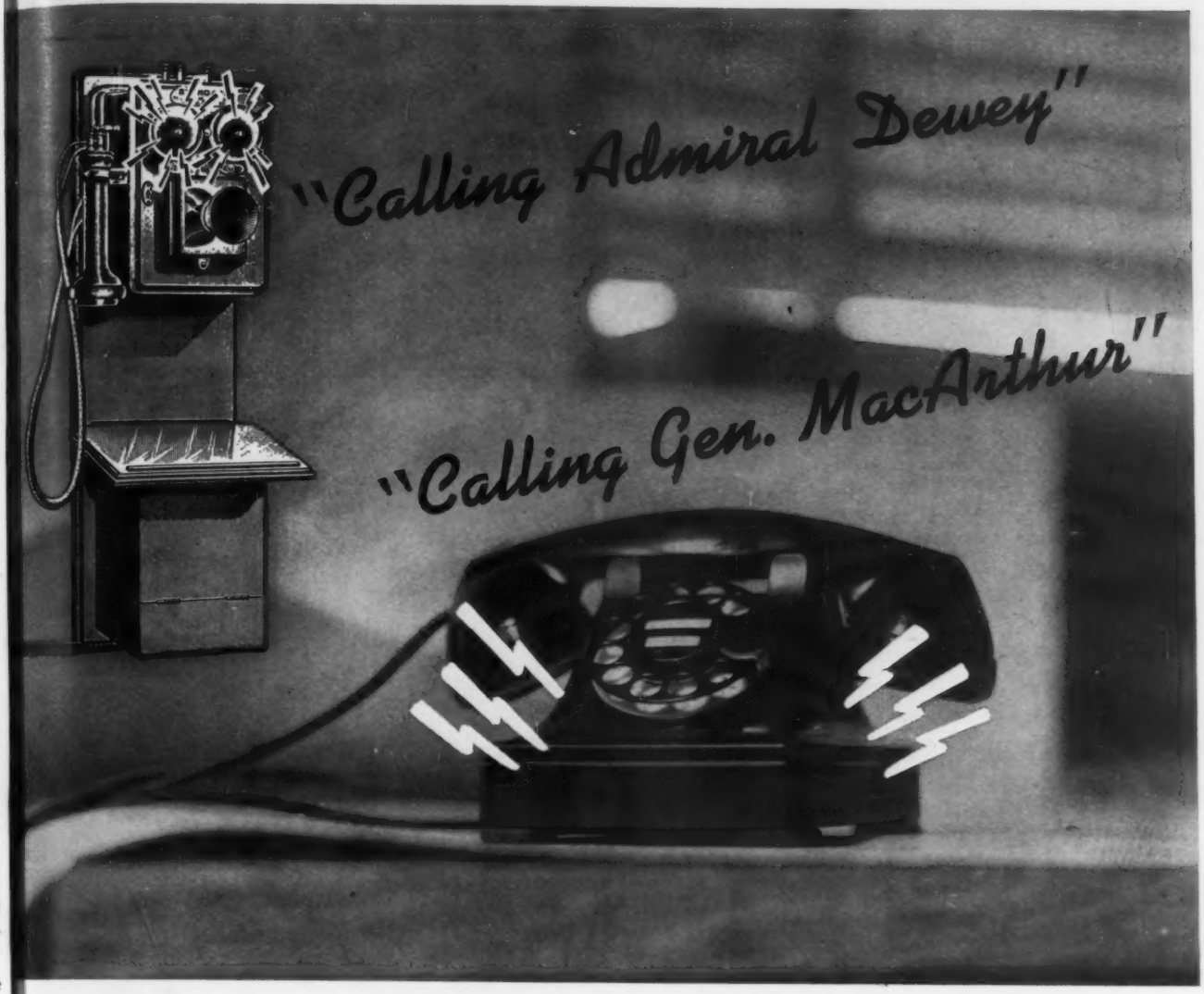
Production Tester

(*Continued from page* 61)

the contact arm on any desired contact point.

As the arm revolves, the drive shaft also turns a large indexing disc. This disc is furnished with a scale numbered from 1 to 120, corresponding to the contact points. The numbered scale is visible through a window in the front panel. If all elements in the set under test are within required limits, the motor drive continues without interruption through all circuits. If a resistor is missing, open, shorted, or out of tolerance, the reject relay in the thyration circuit is operated. The motor is cut off, a magnetic brake is applied and a red "Reject' lamp lights. The operator notes the number of the defective circuit appearing in the window on an inspection tag. Then the "Reset" button is pressed, which resets the reject relay and allows the motor drive to start again. This procedure is repeated in the event other defective circuits are encountered. At the end of the test, the inspection tag is marked with the numbers of the circuits that are defective from the standpoint of resistance.

Upon completion of the resistance test, the reactance test is made, using the bridge circuit diagrammed in Fig. 3. This can be done manually, the operator pushing a control button marked "Reverse", or the change can be made automatically. Around the periphery of the indexing disc, provision is made for plugging in two projecting stops. These are arranged so that when they revolve on the disc they actuate a microswitch. The microswitch is connected in multiple with the "Reverse" switch. The circuit is arranged so that at the end of the resistance test, when the microswitch is closed, d.c. is removed from the bridge and two audio frequencies are applied. At the same time, the first motor is cut off, another motor starts and reverses the direction in which the switch arm travels and an amber pilot light is turned on. The switch arm now retraces its path, comparing all of the circuits for capacitance and inductance variation. The second projecting stop is placed on the disc to



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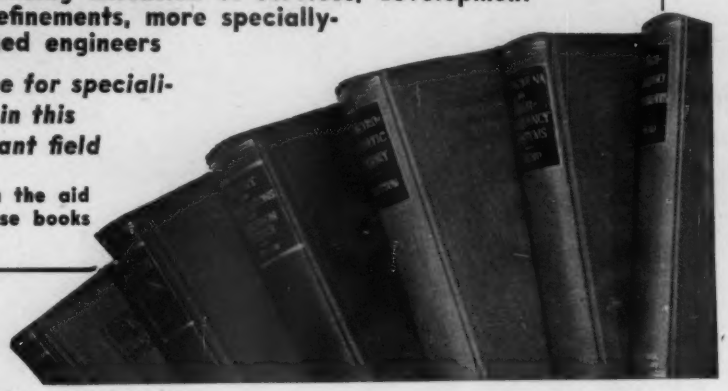

THIS LIBRARY was selected by radio engineering specialists of the McGraw-Hill publications to give a well-rounded view of communications engineering theory, applications, and special techniques. From important tube and radio fundamentals to special emphasis on high-frequency problems, the essentials of this field and its complete modern background are grouped here, for the aid of those who wish to prepare quickly for design and research work in the vitally important and expanding field of war communications engineering.

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close the microswitch when the rotary arm gets back to the first circuit. When this occurs, the motor is automatically cut off and the unit is ready to test another set. As in the case of the resistance test, the arm will stop revolving when the reactance of circuit elements in the two sets does not match. The numbers of circuits that are defective may be noted on the inspection tag by the operator.

The ability of the device to make 120 circuit tests may seem unnecessary to engineers who are not confronted with the problem of checking equipment using 15 or 20 tubes. However, excess testing capacity which will obtain if a 4 or 5 tube unit is to be tested need not be wasted in most cases. Any number of sets with any number of circuits can be tested if the total number of circuits does not exceed 120. Two or three sets of the same type may be equipped with duplicate connecting cables so that as one is being tested others can be connected up for test or disconnected after test, thus increasing the rate of production.

Separate Resistance-Reactance Tests

Before going into circuit considerations, it might be well to point out the need for two separate tests, one for resistance and one for reactance. Two tests are made in order to secure the greatest amount of information concerning the set under test. Obviously, if the circuit under test contains just capacity or a series combination such as *RC*, *LC* or *RLC*, a d-c test would only detect shorted capacitors. And shunt circuits such as *RC*, *LC*, *RL*, *RLC* cannot be compared readily with d.c. applied to the bridge insofar as the reactive component is concerned. If an attempt were made to check resistance and reactance values simultaneously by applying an a-c voltage to a d-c bridge, there would be the possibility that two incorrect values of shunt *R* and *C*, for instance, might result in an impedance value equal to the correct *RC* summation, thereby falsely indicating a good circuit. By first subjecting every circuit capable of passing direct current to a true d-c test the possibility of error can be avoided and an accurate resistance test can be made as well.

In the case of the reactance te

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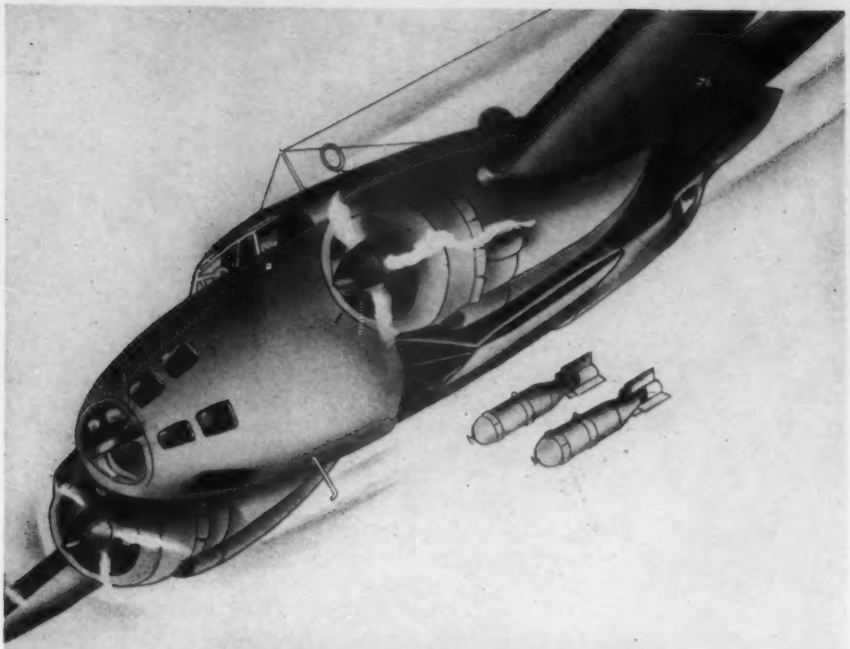

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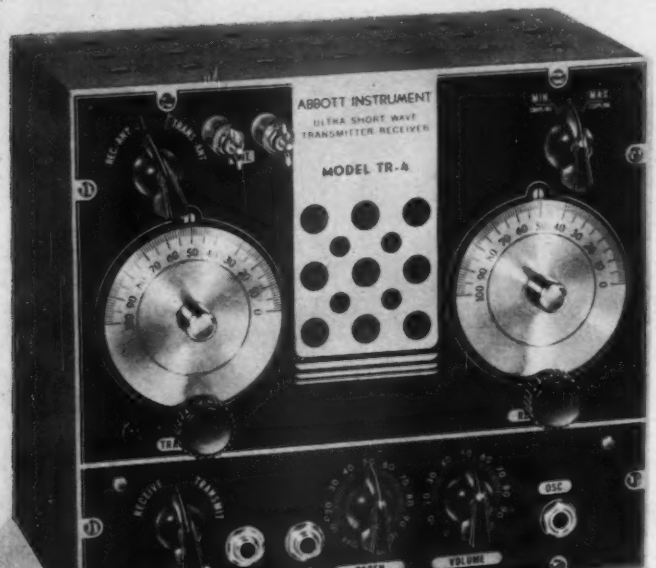

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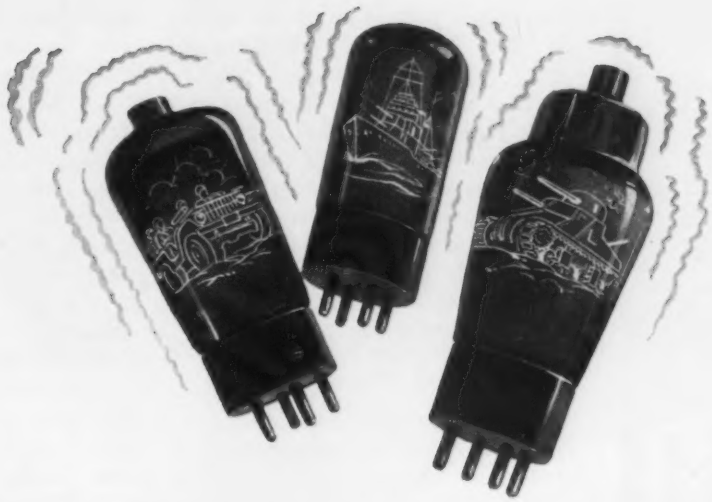
if just one frequency is applied t the bridge a serious loss in flexibi ity will occur. At extremely low an high values of resistance (or re actance) bridge sensitivity falls of appreciably. For example, with 5 k applied to the bridge it would b extremely difficult to detect 10 per cent variation in a 1 μfd capacito because of its low value of reactanc at this frequency. At 35 cycles, how ever, the reactance would appear a several thousand ohms rather tha several ohms, thus effectively rais ing the bridge sensitivity. Natur ally, the reverse is true in the cas of small capacitances.

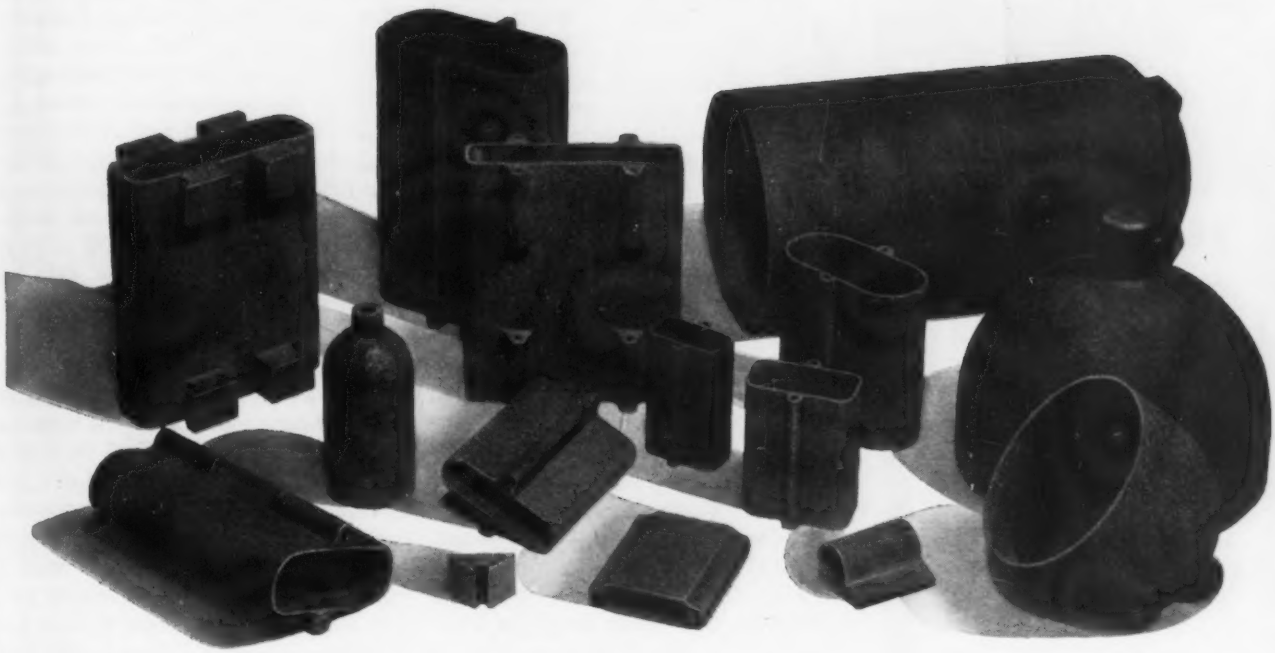
The basic circuit chosen for th bridge configuration is one in whic the top ratio arms are composed o fixed resistors of 20,000 ohms. I order to maintain uniform respons with this circuit, it becomes neces sary to either vary the input voltag or change the values of the rati arms. Each of these plans involves prohibitive amount of comple switching in accordance with varia tions in the external circuits unde test. Furthermore, uniform respons is unnecessary because it is rarel required that all components be hel to the same degrees of tolerance Thus, even if uniform response wer obtained, some method would have t be provided so that bridge sensitivit could be varied, depending upon th specific requirements of each circui tested. The only requirement for device of non-uniform sensitivity i that adequate performance capabil ities under the most unfavorable con ditions be provided, together with simple means of limiting the sensi tivity where wider tolerances are de sired then will obtain at full gain.

Avoiding Transient Troubles

The problems encountered in th design of a suitable circuit for mak ing a true d.c. test of resistanc values are numerous. At the outse d-c amplifiers were looked upon wit disfavor because of their inheren drift characteristics, plus the prob lem of eliminating the effects transient voltages. The matter transients is one of considerable im portance when it is considered tha in going from a circuit of severa hundred ohms to one of severa megohms the voltage changes on th bridge arms are of the order of 10 volts. Further, since it is almost



Tubes bouncing around



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mechanical impossibility to insure that both contactors "make" at the same instant on all sets of contacts, the condition becomes more serious. Observing the transients set up on the bridge arms with an oscilloscope shows this clearly. In order to avoid false rejects due to transients, it is necessary to disarm the trigger circuit until the contactors are centered on their respective test circuit contacts, about which more later.

Extraneous 60 Cycle Pickup

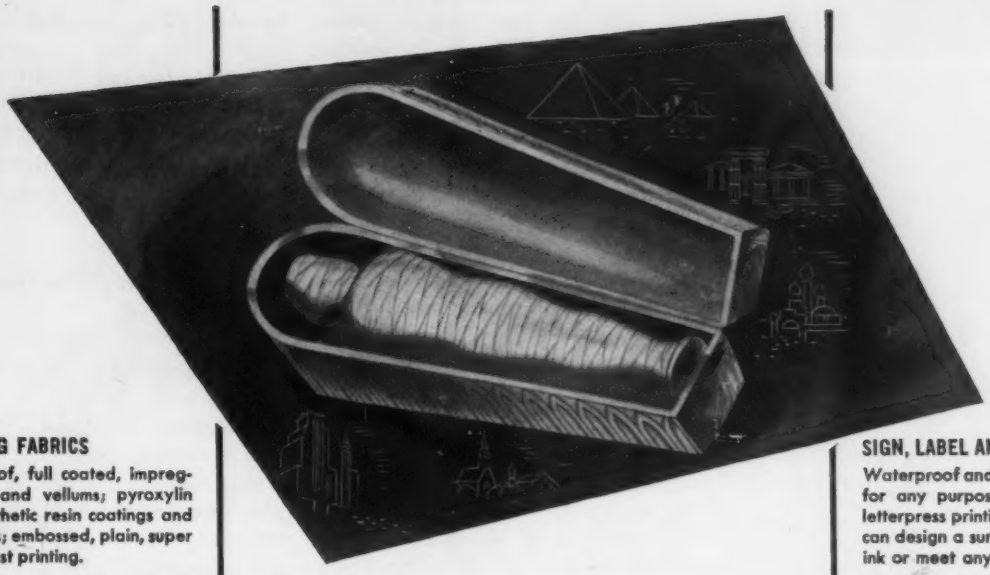
Another problem encountered in making the resistance test is that of extraneous 60 cycle pickup on the cables to the external bridge arms. With the compromise value of 20,000 ohms chosen as the top ratio arms of the bridge, preliminary tests indicated that an amplifier gain of 40 db would be required. While this is not considered high gain it is still sufficiently high to make any attempt to dangle three foot input leads around indiscriminately unwise. The problem is further complicated by the fact that the testing speed of one circuit per second will not permit the use of large *RC* filters to eliminate the hum, because of their time constants when subjected to large transient voltages. *LC* combinations were tried in several initial circuits, but these too presented the problem of direct inductive pickup from strong 60 cycle fields.

In the final circuit adopted, power is supplied to the bridge arms *A* and *B*, the test set and the standard set, by a 200 volt-regulated supply. Capacitors C_1 attenuate the 60 cycle pickup on the diode plate load resistors (R_1) while *C* offers a low reactance path for the 400 cycle signal source across the load resistors. Each diode cathode feeds one end of the primary of the bridge transformer T_1 and the return circuit back to plate is through a low impedance source of 400 cycles. The presence of R_2 and R_3 allows adjustment of the circuit to "balance" by compensating for variations in diodes. C_3 tunes the primary of T_1 to resonate at the sigual frequency, attenuating the residual harmonics produced when the circuit is balanced. When the bridge (*A*, *B*, set, standard) is in balance, the potential drop across R_1-R_1 is zero. Since the 400 cycle source is fed to the diode plates in phase and appears at opposite ends of the primary of T_1 in phase and equal in amplitude it tends to cancel. If, however, an unbalance occurs in the bridge, the potential drop across R_1-R_1 causes the current flow through the diodes to vary in opposite directions, one drawing more current, the other less. This modifies the flow of 400 cycles so that the voltages appearing at the ends of T_1 are no longer equal in magnitude. Hence current will flow through the entire winding in one direction and produce a greater output voltage.

One advantage of this method of controlling an a-c signal by a shift in d.c. is that, since small d-c voltages (in the order of 20 mv) are to be detected, the a-c voltage may also be small. Practice has shown that the 400 cycle source need not deliver over ½ volt. A further increase in amplitude produces a more unfavorable ratio of balanced to unbalanced output voltages. This, then, means that even large d-c transients of the order of several hundred volts on the diode plates can only produce a limited amount of a.c on the first amplifier grid, protecting it from unduly large overloads. Resistance variations of 5 percent from 200 ohms to 5 megohms can easily be detected as shown in Fig. 4.

Sensitivity Adjustments

In order to limit the sensitivity in the mid-range provision is made to clip in resistors (*X*, *Y*, *Z* in Fig. 2 and 3) which effectively shunt the bridge. These points are easily accessible physically because the back ends of the rotary switch contact points have extruded tips which project through to the front side of the Bakelite sub-panel. Small resistors fitted with clips of the type used in some octal sockets form a snug fit on these extruded tips. To change resistors, which in effect limit the tolerance values of the external circuits, it is only necessary to drop the hinged front cover plate of the tester and clip on new values of resistance shunts. The bridge circuit for making the reactance test is conventional. Capacitors C_4, C_5 (3–30 $\mu\mu$f) are used to balance the slight variations in wiring and transformer capacitances. Actually, in practice the same components *A*, *B* and T_1 are used in both bridges, the changeover being accomplished by means of two dpdt relays which are actuated in proper sequence by the control circuits.



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M

The need for two frequencies as a signal source for the reactance test has already been explained. In practice some experimentation is advisable in adjusting respective levels of these two frequencies. This is dictated by the tolerance requirements for each specific type of equipment to be tested. If the requirements place greatest emphasis on maintenance of close tolerances on high reactance values, more 5 kc amplitude is employed. The 35 cycle amplitude is similarly adjusted to take care of the low reactance values. This is a compromise but it does allow considerable leeway on the part of the set-up engineer.

The question of tolerance values leaves something to be desired on the reactance test in that the same sensitivity control resistor used in making the resistance test is of necessity employed when making the reactance test. However, this is largely offset by the fact that bridge sensitivity in the reactance position can be controlled by varying the amplitude of both the 35 cycle source and the 5 kc source independently. Any attempt to switch the tolerance control resistor involves a cumbersome and extremely complex switching system. Furthermore, in actual practice it would be impossible to hold the tolerance value of a capacitor to the same percentage as that of the resistance when the two are in shunt, since it is obvious that if the resistor was held to plus or minus 5 percent tolerance the percentage variation of the reactance value would of necessity have to be greater. Fortunately also, capacitors in general need not be held to as close limits as resistances, commercial practice often being to hold the majority of capacitances to at least twice the percentage tolerance to which resistance is held. Obviously, if the circuit under test contains no d-c path back to ground it can be given an excellent reactance test because the tolerance control resistor may then be chosen to limit sensitivity on the reactance test alone.

No set figures can be given regarding the ultimate capabilities of the unit on a reactance test, particularly as resistance components are so often included in circuits. However, inductance values of 1 milhenry or larger can easily be checked. A variation of 10 percent in the value of large electrolytic capacitors can be checked at one end of the scale, while 30 percent variation of a 50 $\mu\mu$f capacitor can readily be detected at the other extreme. Smaller capacitance variations are likely to become confused with slight variations in the capacitance of connecting cables.

"Arming" the Tester

The word "arming" commonly used in ordnance work to indicate when a bomb or projectile is ready for detonation, may be appropriately used in connection with the disabling circuit used in the tester to prevent false rejects which would otherwise be caused by transient voltages set up as the switch arm shifts from one circuit to the next.

The arming switch makes it impossible for the thyratron to fire and thus lock up the reject relay, except under proper circumstances. The logical time to arm the thyratron is when the two moving contactors on the bridge arms are exactly centered on a pair of contact points. The thyratron must then be disarmed as the contactors approach the next pair of contacts. This is accomplished by removing the amplifier output connection from the thyratron grid except under the condition mentioned. Thus large transient inputs to the amplifier do not cause difficulty as they do not reach the thyratron grid.

Several methods of arming were considered but the one finally selected proved most effective. An additional set of contact points was installed outside the outermost ring of bridge contact points. Alternate contacts of the total of 120 are connected together in two sets. These are connected to the amplifier output and to the thyratron grid. When a shorting shoe connects them together the circuit is "armed" and, if the bridge is unbalanced, the thyratron will fire. The shorting shoe is mounted on the opposite end of the rotary switch arm and is under spring tension to counteract pressure set up by the bridge circuit contactors. The shoe is placed in such a way that the contact is made just as the contactors are on the center of a pair of contacts and immediately broken as the arm moves on. This assures correct timing of the arming cycle and the wiping action of the shoe keeps the contacts clean

DESIGN IT RIGHT THE *first* TIME!

. . . *specify* WALKER-TURNER FLEXIBLE SHAFTING

The first battle in every war of mechanized weapons is fought at the drafting table. There must be no guesswork here. The engineer must be right the *first* time. If he is not, the fighters who man his machines may lose a battle, a campaign, even the war.

When flexible shafting is needed for power transmission or remote control, the designer who specifies WALKER-TURNER FLEXIBLE SHAFTING is sure to be right the first time. For this product has met the hardest tests of industry and war in thousands of machine tools, aircraft and other equipment.

All WALKER-TURNER FLEXIBLE SHAFTING is designed and manufactured entirely in the Walker-Turner Plant, under rigid control and inspection. If your Engineering Department is struggling with a problem involving flexible shafting, let us look it over. We may have the answer in our engineering files.

WALKER-TURNER COMPANY, INC.
1423 Berckman Street . . . . Plainfield, N. J.

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COMPANY, INC.
PLAINFIELD, N.J.
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FLEXIBLE SHAFTING

FOR REMOTE CONTROL AND POWER TRANSMISSION

Making "ENDS" Meet

• • • —Bringing America closer to Victory by manufacturing Radio Sockets and Connectors for perfect electrical contacts in communication applications is an important wartime job entrusted to The Astatic Corporation. All the engineering skill and precision which formerly went into the manufacturing of Astatic Microphones and Pickups is now utilized and reflected in Astatic Radio Plugs and Sockets, Co-Axial Cable Connectors, and similar equipment for the U. S. Army Air Corps and the Navy.

The ASTATIC Corporation
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ASTATIC

CARTER SOLVES YOUR *Dynamotor* PROBLEMS

For many years, Carter Dynamotors have been a familiar part of the specifications of leading Communication Equipment Manufacturers, Police Departments, Government Agencies, etc. May we suggest you submit your Dynamotor requirements too, and see for yourself the reason for this recognized preference.

The latest catalog of Carter Dynamotors, Converters, Permanent Magnet Generators and Dynamotors, and special rotary equipment will be sent upon request.

Carter Motor Co.
Chicago, Illinois

1606 Milwaukee Ave. Carter, a well known name in radio for over twenty years. Cable: Genemotor

and the circuit free from faults du to poor connections.

Conclusion

The tester described accomplishe one important purpose when it an alyzes equipment coming off the pr duction line and prevents defectiv units from reaching the dynami test bench. The other possibility o obtaining more production throug use of the tester with unskilled hel lies in the analysis of the difficultie thus turned up. This falls withi the province of the test enginee who sets up the equipment. In orde to realize this benefit, he must care fully check each circuit and includ in his instructions to the servic worker the most likely cause of trou ble for each numbered circuit.

Combinations of numbers of cir cuits that show up as defective ca generally be attributed to a defectiv part common to all of them. It ma take two or three days to set up th unit and make an analysis on a new type of equipment. The data thu obtained, however, will enable un skilled workers to locate defective parts and wiring faults at a fa faster pace than even a skilled trou ble shooter can hope to attain using conventional methods.

• • •

CALLING DOWN-UNDER

Nola Luxford, a native of New Zealand, has installed a home-recording phonograph in her apartment where the boys from Australia and New Zealand can record their voices to send to their homes 10,000 miles away. Miss Luxford supplies the records and pays the postage. So far there have been about 1,000 personal voice messages sent home to the boys' families. The fliers and hostess are listening to a playback of a voice record made by one of the boys. Redgi Hoskin, N. Z., Mel Skelton, Australia, Miss Luxford, Jack Margetts and Raymond Beaton, both of New Zealand

LOOK WHAT THIS hp INSTRUMENT can do for you

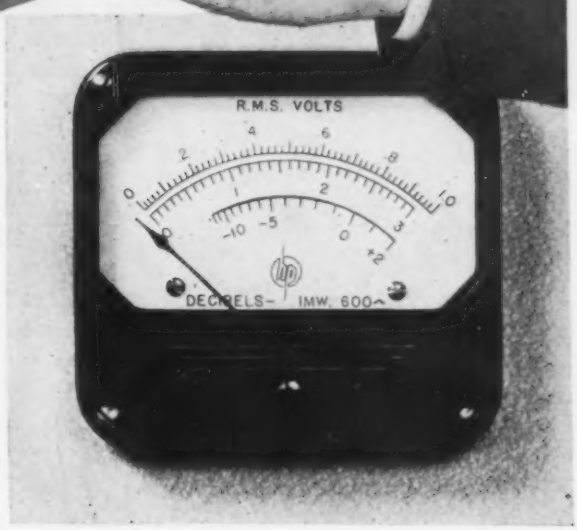
Meet the Requirements of the Most Exacting A. F. Production Test Problem. Combined with an *-hp-* resistance tuned Oscillator all of the measurements usually required on audio equipment can be made quickly and accurately with a minimum of additional equipment.

Measure Total Harmonic Distortion at Nine Specific Frequencies. The Model 325B is designed to measure total harmonic distortion at the nine specific frequencies recommended by the FCC for measurements on frequency modulation as well as amplitude modulation equipment. On special order, filters for other frequencies from 30 cps to 20 KC can be supplied. The amplifier and voltmeter section are flat from 10 cps to 100 KC so that harmonics as high as the 5th of 20 KC will be correctly indicated.

Measure Noise and Hum Level in A. F. Equipment. Sufficient sensitivity is available in the Model 325B to measure noise and hum level in audio frequency equipment such as amplifiers and broadcast equipment. With the addition of a detector, distortion and noise level can be measured in carrier output of transmitting equipment.

Use It as a Vacuum Tube Voltmeter. The instrument can be used as a voltmeter for measuring voltage level, power output, amplifier gain, and in making all of the other measurements for which a high impedance voltmeter with a wide frequency range is necessary.

The vacuum tube voltmeter section is a two stage amplifier with feedback to insure stable operation. It is identical with the Model 400A voltmeter except the frequency range is limited to 100 KC. The input amplifier of 325B can be used directly with the voltmeter section to give full scale indication on 3 MV.



Voltmeter face. Note that voltage and D. B. are calibrated separately.

Use It as a High Gain Amplifier. Terminals at the meter output are provided for waveform observations with an oscilliscope and to allow the instrument to be used as a high gain amplifier. The overall gain is 75 DB from 10 cps to 100 KC.

Model 325B Noise and Distortion Analyser *is almost indispensable for laboratories or production tests in the audio frequency field. Many outstanding features are not mentioned here. Write for complete details today.*

HEWLETT-PACKARD CO.
STATION A, BOX 135 Z, PALO ALTO, CALIFORNIA

NEWS OF THE INDUSTRY

Latest information on licensing of alien-owned patents; three electronic workers honored by President for speed-up ideas; review of Nikola Tesla's accomplishments; channel allocations for War Emergency Service; FCC news; vital statistics on the electronic industry; radio news

Armstrong Gets Edison Award

THE EDISON MEDAL for 1942 has been awarded to Dr. Edwin H. Armstrong, professor of electrical engineering at Columbia University, well known for his contributions of the regenerative and superregenerative circuits, the superheterodyne and the frequency modulation system of communication. This award is made annually by an AIEE committee for "meritorious achievement in electrical science, electrical engineering or the electrical arts."

Knowlson Leaves WPB

JAMES S. KNOWLSON has resigned as Vice Chairman of the War Production Board, in order to return to his duties as President and Chairman of the Board of Stewart-Warner Corp. in Chicago. With his firm now handling a large volume of war orders, Mr. Knowlson felt he could no longer remain away from its helm. He will remain within the WPB organization on a "when actually employed" basis, in order that he can be called as consultant or special assistant from time to time.

Mr. Knowlson entered OPM in September 1941 as Deputy Director of Priorities. After establishment of WPB he was made Director of Industry Operations, and was responsible for initiating and executing the vast program for conversion of industry from peace-time to war work. Last summer he was made Vice Chairman of WPB and was designated to serve as Mr. Donald Nelson's deputy on the Combined Production and Resources Board. Mr. Knowlson was well known to all radio manufacturers since he had served as president of the Radio Manufacturers Association.

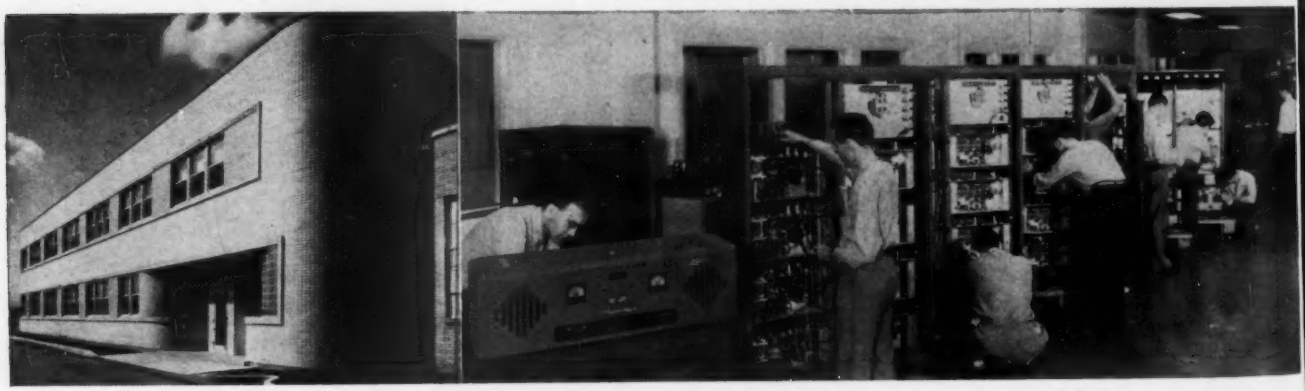
ANEPA

THESE INITIALS STAND for the Army-Navy Electronics Production Agency, a Washington coordinating agency manned partly by Army and Navy men and partly by civilian engineers, radio technicians and industrialists. Under the guidance of ANEPA chief production engineer George W. Parkins, the agency monitors production and distribution in the communications manufacturing industry, doing everything possible to keep electronic equipment flowing steadily to the armed forces and our Allies.

Lists of Patents Usable on Royalty-Free Basis Available from APC

THE NUMBERS AND TITLES of nearly 3000 alien-owned electronic patents seized by the Alien Property Custodian are now obtainable from the Office of Alien Property Custodian, 135 South LaSalle St., Chicago. The list of some 125 patents in Class 177—electric signalling—is priced at 10 cents. The following three other lists are priced at 25 cents each: Class 178, with some 450 patents relating to telegraphy; Class 179, with about 790 patents on telephony; Class 250, with about 1675 patents in the radiant energy group. Other classes which contain some electronic patents are: Class 171—electricity generation; Class 172—electricity motive power; Class 173—electricity connectors; Class 174—electricity conductors and insulators; Class 175—electricity general applications; Class 176—electric lamps.

In examining lists of APC patents, the approximate age of a patent can be determined from its number. Thus, patent numbers below 2,000,000 were issued in 1935 or earlier, and can in most cases be



RESEARCH, DEVELOPMENT and production of radio and electronic equipment for military purposes are combined in the new Motorola engineering building, built by Galvin Mfg. Co. immediately adjacent to their main plant. Motorola engineers in this building are working on numerous special electronic problems assigned to them by the U.S. government. The above illustrations show the front of the new building and a view of a production line in the Radio Research Production Department.

FROM THE OFFICE OF THE PRESIDENT

To Sales Manager

How about preparing for new markets for after the war? How shall we go about it?

Bill

OUR ENGINEERING STAFF IS READY TO WORK WITH YOU ON WAR AND POST-WAR† PROBLEMS

Whether you are faced with a problem of war production . . . or you are planning for post-war markets . . . our staff of engineers is at your service. Shirt-sleeve work . . . consultation . . . research . . . we are ready to tackle anything and everything in the following phases of engineering:

*Member of A. C. C. L.

- ★ Sub-contracting in the manufacture of special parts, tools, gages, and other equipment.
- ★ Precision measurements and calibration down to 1/100,000th of an inch.
- ★ Tests on raw materials, accessories, and consumer goods.
- ★ Special tests on heat, light, sound and vibration, and electricity.

When writing, please indicate specifically the engineering problems you are interested in.

† An ENGINEERING PLANNING BOARD . . . composed of engineers with long experience in the field . . . is now ready to work with industry in anticipating the problems and the special requirements of the post-war era.

* *American Council of Commercial Laboratories*

UNITED STATES TESTING COMPANY, INC.

ESTABLISHED 1880

HOBOKEN, NEW JERSEY

PHILADELPHIA, PA. GREENSBORO, N. C. WOONSOCKET, R. I. CHICAGO, ILL. NEW YORK, N. Y.

"...IN-RES-CO resistors have that essential designability"

★ Manufacturers of sensitive equipment for industrial and military needs, have found the integrating advantages of IN-RES-CO resistors of particular importance where space is limited. These exceedingly compact components offer dependability under severe atmospheric and electrical conditions because each must pass a voltage breakdown overload test of 100% their rated working voltage. Literature will be sent promptly on request without obligation.

TYPE RL (at left), ½ Watt, Non-inductive, Standard tolerance ½%, Maximum resistance 500,000 ohms, Size ½" diam. x ½" high.

TYPE SL (at right) 1 Watt, Non-inductive, Standard tolerance ½%, Maximum resistance 1 Megohm, Size ½" diam. x 15/16" high.

IN-RES-CO

INSTRUMENT RESISTORS COMPANY

25 AMITY ST., LITTLE FALLS, N. J.

disregarded. Numbers around 2,175,000 were issued the first part of 1940.

Legitimate American business concerns can secure licenses only for those patents which were not exclusively licensed to American concerns prior to seizure by APC. These licenses are on a royalty-free, non-exclusive basis for the life of the patents. The license fee for the first patent is $50, with an additional fee of $5 for each other eligible APC patent desired by a licensee. The patents involved are all regular U. S. patents, copies of which are obtainable in the usual manner at 10 cents each from the Commissioner of Patents, Washington, D. C.

Since the above-mentioned lists do not indicate which APC patents are ineligible due to exclusive licensing contracts, it is necessary to send lists of likely patents to the Office of Alien Property Custodian in Chicago to determine which are eligible for royalty-free licensing. Many owners of foreign patents gave exclusive licenses to American firms, and these remain in effect. Also American branches of certain foreign firms are being allowed to retain control of their U. S. patents for as long as these patents are used in the best interests of the United States.

Since many patents in the field of electronics represent improvements over other patents, the possibility of infringing on other American-owned patents must be considered when using a royalty-free APC patent.

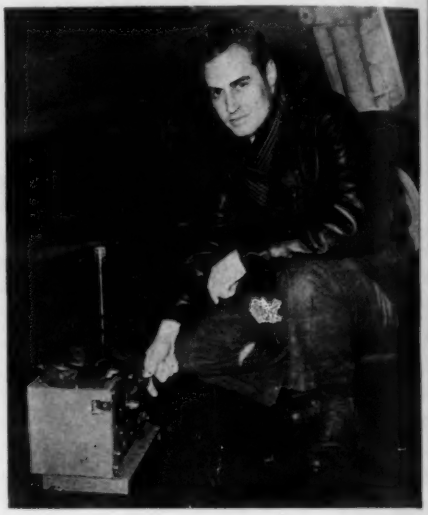
Royalties due alien or enemy owners on existing exclusive agreements are payable to APC. An exclusive licensee under an enemy patent may relinquish his contract, however, and accept a non-exclusive royalty-free license. This action has already saved one American munitions manufacturer considerable money.

Patents owned by nationals of enemy-occupied countries, such as France and Holland, are being licensed on essentially the same terms as enemy patents, except that the patents remain royalty-free only for the duration of the war and six months thereafter. The license may continue after that, but royalties must then be paid on the basis of prevailing commercial practice. When American firms or citizens hold non-exclusive patents, APC will issue additional licenses.

Ideas Bring Top Honors To Three Electronic Workers

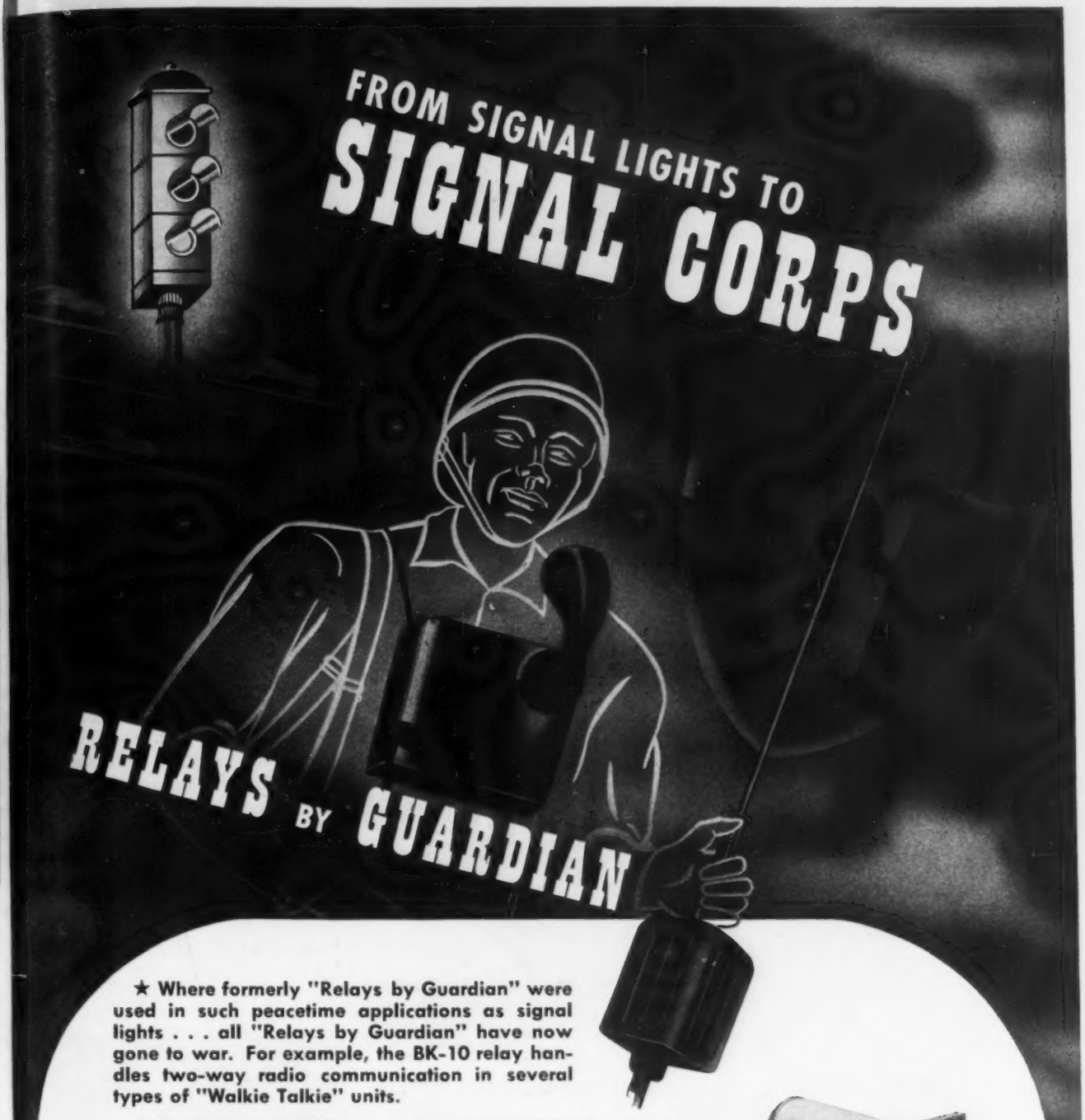
THREE OF THE SIX men who recently received WPB's highest honor for soldiers of production, the "Citation for Individual Production Merit," are engaged in the production of electronic equipment. Their suggestions for saving time and vital manpower in production of military equipment brought personal presentations of the awards by President Roosevelt at the White House.

Edwin C. Tracy, an RCA Victor Division employee, received his citation for developing an electronic oscillator which is capable of making required tests of radio equipment in fighting planes in three minutes, without removing the equipment from the plane. The new oscillators are being sent to every American flying field. The results obtained with his method are more accurate than were possible with the former procedure requiring eight hours. Reducing the time a plane is held from combat for test purposes has the effect of increasing the number of planes available for combat. Tracy is an RCA field engineer born in Turkey of American missionary parents 31 years ago, and has done considerable work on television equipment as well as on special radio equipment for Naval aircraft.



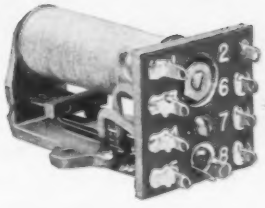
Edwin C. Tracy, RCA Victor Division employee, developed this special electronic oscillator for testing radio equipment in fighting planes

Madison Butler, assistant chief inspector of Stromberg-Carlson Tel. Mfg. Co., received his WPB award for the development of a visual



★ Where formerly "Relays by Guardian" were used in such peacetime applications as signal lights . . . all "Relays by Guardian" have now gone to war. For example, the BK-10 relay handles two-way radio communication in several types of "Walkie Talkie" units.

It facilitates switching over from "send" to "receive." Built for operation at 12 volts, the BK-10 relay makes and breaks contacts firmly when the potential is reduced to 9 volts. Contact combination is made up of two stacks, one being single pole, double throw—the other 1 make, 1 break. Contact points are highly tarnish resistant sixteenth-inch palladium. The compact, light weight BK-10 relay weighs four ounces and measures 3⅛" x 1½" x 1⅜". It is built to U. S. Army Signal Corps specifications.



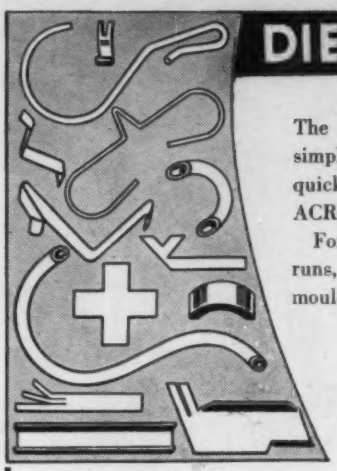
Series BK-10 Relay

Planning for today or post-war? Send for Bulletin 195 describing this and other "Relays by Guardian" used in aircraft, ground and mobile communications.

GUARDIAN ELECTRIC

1625 WEST WALNUT STREET CHICAGO, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY



DIE-LESS DUPLICATING

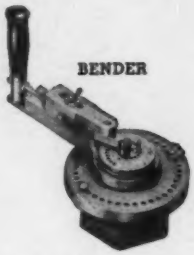
The parts shown are typical of the great variety of simple or intricate forms and shapes which can be quickly duplicated to a tolerance of .001" with DI-ACRO Precision Machines—Shears, Brakes, Benders.

For experimental and research work or production runs, DI-ACRO Units form angle, channel, tube, rod, moulding, wire, strip stock; shear stock sheets, trim duplicated stampings. With DIE-LESS DUPLICATING, Man Hours and Critical Materials are frequently saved. High hourly production rates can be easily maintained. Multiple units provide large output if desired.

SHEAR

DI-ACRO PRECISION MACHINES

BRAKE



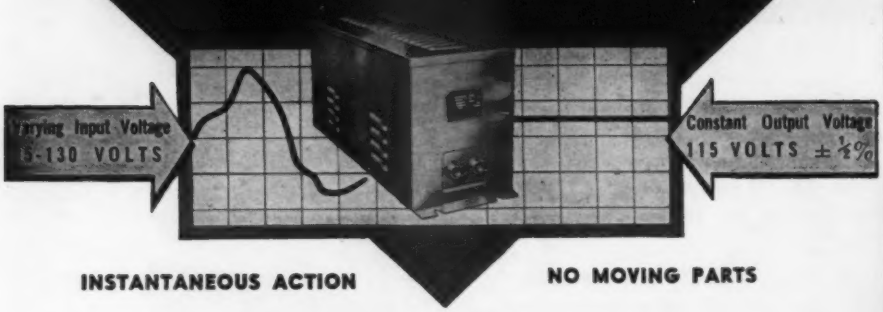
BENDER

WRITE FOR CATALOG—Send today for new 32-page catalog—"Metal Duplicating Without Dies" giving full information on the capacity of Di-Acro Shears, Brakes, and Benders and illustrating their great variety of applications.

O'NEIL-IRWIN MFG. CO. 321 8th Ave. S. Minneapolis, Minn.

STABILIZED A. C. VOLTAGE

UP TO 25 KVA



INSTANTANEOUS ACTION NO MOVING PARTS

When a precision electrical device or a critical process is powered from an AC line, a Raytheon Voltage Stabilizer will permanently eliminate all of the detrimental effects caused by AC line voltage fluctuations. Made for all commercial voltages and frequencies, single or three phase.

Raytheon's twelve years of experience in successfully applying the Stabilizer to hundreds of perplexing voltage fluctuation problems is at your service. It will pay you to take advantage of our engineering skill.

Write for Bulletin DL48-71 JE describing Raytheon Stabilizers.

RAYTHEON MANUFACTURING CO.
100 Willow Street WALTHAM, Massachusetts

Madison Butler, assistant chief inspector of Stromberg-Carlson Telephone Mfg. Co., developed a lamp-indicator instrument for testing field telephone switchboards. Details are a military secret. He is shown here with an instrument developed for testing telephone-type relays

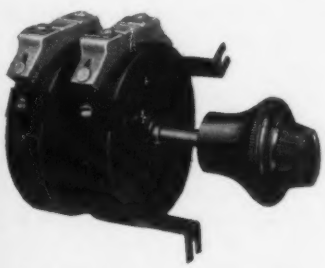
lamp-indicator which cuts testing time of Signal Corps field telephone switchboards from 80 man-hours to one man-hour. It also permits the use of comparatively unskilled workers for test work on these units after only a short period of training. Since 1100 units have already been tested by this new method, the total saving so far amounts to approximately 11,000 men-days or nearly 37 man-years of work.

Clinton R. Hanna, manager of the electro-mechanical department of Westinghouse Research Laboratories, was given a citation for developing an electrical device which greatly increased the effectiveness of American tanks. His suggestion is described by Army men as "an outstanding contribution" to ordnance material, and is of course a military secret.

Clinton R. Hanna, Westinghouse research engineer who suggested a method of increasing the effectiveness of Army tanks, is shown here with the Silverstat voltage regulator he developed to control electrical equipment

FORTY-THREE STEPS OF CONTROL

in four inches!



Concentric arrangement for back of board mounting

ARMY E NAVY

The new Ward Leonard 4-inch Pressed Steel Rheostat offers the happy combination of a small sturdy power rheostat with a large number of steps and ample current carrying capacity. Like all Ward Leonard Pressed Steel Rheostats this model may be arranged for front of board, rear of board and multiple assembly mounting. Other types and sizes also available. Send for descriptive bulletins.

WARD LEONARD

RELAYS • RESISTORS • RHEOSTATS

Electric control (WL) devices since 1892.

WARD LEONARD ELECTRIC COMPANY, 32 SOUTH STREET, MOUNT VERNON, NEW YORK

WITH

Synthite* PX-5

Insulating Transformers, like the 8.3 KVA air cooled unit above, provide isolation of circuits having a potential difference of 30,000 volts. This certainly is of interest. To insure non-failing insulation, the manufacturer, Nothelfer Winding Laboratories of Trenton, New Jersey specified DOLPH'S SYNTHITE PX-5 Black Baking Varnish for impregnation of all their windings.

SYNTHITE PX-5 cures by heat induced chemical polymerization, leaving no trapped solvents or uncured varnish even in the deepest interstices of large coils. Possessing excellent bonding properties, moisture resistance and high dielectric strength, it is ideally suited for use on the newer magnet wires and with Class B insulation.

Dolph's

JOHN C. DOLPH COMPANY

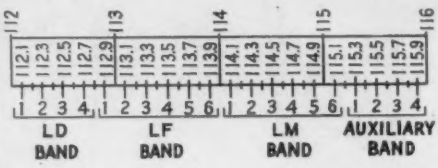
Insulating Varnish Specialists

169-A Emmet St., Newark, New Jersey

Channel Allocations for WERS

THE OFFICE OF CIVILIAN DEFENSE has explained further the proposed "Tri-Part" plan for War Emergency Radio Service (described in the last issue of ELECTRONICS), as follows: In following the plan for a single control center, the channel assignments in the 112–116 Mc band are as specified in the accompanying chart.

By FCC regulations all stations in the 112–114 Mc region are required to maintain their frequency within 0.1 percent, while those between 114 and 116 Mc may be operated with 0.3 percent tolerance. Since the closer tolerance can be more easily maintained with equipment installed at fixed points, both the LD and LF channels for communication between fixed points have been allocated in the 112–114 Mc section of the band.



Allocation of channels for War Emergency Radio Service in the 112-116 Mc band

There are twenty channels available between 112 and 116 Mc, allowing 200-kc separation. It is expected that superregenerative receivers will be used almost exclusively in this service, hence this separation will be necessary to avoid interference between adjacent channels.

The four channels available in the LD band may be staggered throughout a warning area between communities to provide communication between the local control centers and the warning district control center. These channels parallel the basic telephone system and provide a means of reaching points outside a community if telephone service fails.

Six separate LF channels are available for communication between the control center and fixed points such as Fire Headquarters, Police Headquarters, Wardens' Posts, Hospitals, etc.

The six channels assigned for LM (mobile) service in the 114–115.2 Mc band are in the low tolerance region and are used for communication between the control center and mobile units of various services in the field.

The four channels in the auxiliary band from 115.2 to 116 Mc have been set aside for use in those cases where additional channels may be needed for other groups and services engaged in civilian defense.

The system is extremely flexible. Direct communication from mobile units to their headquarters can be had by installing a second receiver at that point and tuning it to the LM channel used by that particular service. The mobile unit receiver is then provided with a notched dial. In one position it is tuned to the LM channel assigned to that service for communication with the control center. In the other position it is tuned to the LF channel on which its headquarter's station transmits.

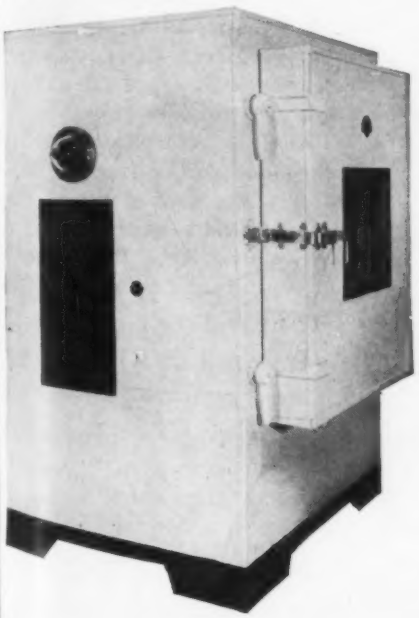
If one or more transmitters are set up at the main control center with notched frequency controls, the sub-control centers and in many cases the fixed stations of the various services can be contacted directly from the control point by the use of the proper LM or LF channel.

A two-way channel may be set up between the main control center and the warning district control center on one of the LD channels, to provide a supplemental service to a point outside of the city which is in close contact with military and state headquarters.

It is absolutely essential that a basic plan be followed in establishing a network of stations for emergency communications. Without it there will be no separation of messages, and interference with message transmission will be the rule rather than the exception. Such a procedure will inevitably result in failure of an otherwise invaluable method of dispatch and control. Experience has shown that a basic plan such as outlined above will provide a system capable of handling an enormous amount of message traffic with a minimum of interference.

The basic plan above can be modified if necessary to meet specific problems which may arise in certain cities. The use of fixed tuned receivers cannot be stressed too greatly. Here again experience has shown that unless this is done much time is lost before contact is established. Where receivers are used to receive more than one channel, the setting should be by notched control, and definite instructions should be issued to make stand-by on one of the channels mandatory.

But can they "TAKE IT" at 40 below?



In this far-flung war, instruments—like men—must be prepared to give their *best* in the face of all kinds of climates. The delicate parts that you manufacture for a field radio . . . may be called on to meet the biting winds of a Russian winter; or the hot, blasting sands of the Libyan desert.

The "Tenneysphere High Altitude Chamber" is constructed for the rigid testing of instruments that have to undergo just such extremes of heat, cold, moisture and dryness. These units meet the test requirements of all U. S. Government Agencies: Army Signal Corps, Navy Bureau of Aeronautics, National Advisory Committee for Aeronautics.

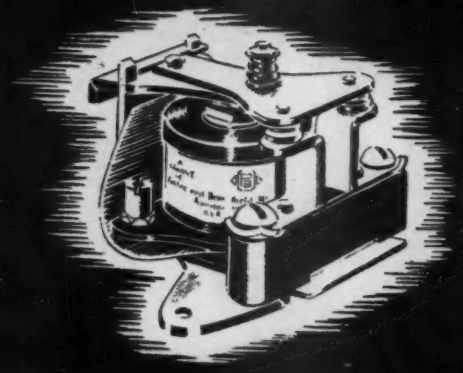
Range of temperatures in standard equipment is from –40° to 150° Fahrenheit—which can be extended to meet special requirements. Observation ports, insulated by multiple plate glass sections, are sealed to prevent interior condensation. Interior is air-conditioned to meet requirements of pressure, temperature and humidity. In the standard unit the pressure is controlled from atmospheric to 50,000 feet of altitude.

For illustrated booklet describing Tenneysphere High Altitude Chambers, Constant and Variable Temperature Baths, Humidity Chambers and All-Weather Rooms, with tables giving specifications for many important installations, write Dept. "E-2".

TENNEY ENGINEERING COMPANY, Inc.

8 Elm St., Montclair, N. J.

Abrams Instrument Company
has long used
Potter and Brumfield Relays
in Special Laboratory
Photographic Timers



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Radio Inspector Requirements for FCC Work are Modified

MEN QUALIFYING AS Radio Inspectors are needed by the FCC for positions throughout the United States involving inspection of radio equipment on ships and aircraft or at land stations, carrying out of frequency runs and harmonic analyses, and examination of radio operators. The positions pay $2000 and $2600 a year. Applicants are rated entirely on education and experience, with no written tests and with liberal allowances for special qualifications or types of experience. Applicants must hold a valid second-class radiotelegraph operator's license, or must demonstrate during the first six months of employment that they are able to transmit and receive at least 16 code groups per minute. Applicants must also be able to drive an automobile, as they may be required to drive mobile laboratories and inspection cars.

For the position of Radio Inspector at $2600 a year, applicants must be in any one (not all) of the following education-experience groups: (1) Four years of technical experience in radio work; (2) Any four-year college course with major study consisting of at least 24 semester hours of physics; (3) A four-year course in electrical or communications engineering; (4) Any time-equivalent combination of the first three requirements. Thus, amateur radio experience under a class A license may be substituted for two years or less of experience.

For Assistant Radio Inspector at $2000 a year, only three years of education or experience in any of the above groups are required.

Qualified persons are urged to apply at once, and will be rated as soon as possible. Application forms can be obtained from the U. S. Civil Service Commission, Washington, D. C. or from most first and second-class postoffices.

Philco Resumes Television Programs

TELEVISION BROADCASTS were resumed by Philco station WPTZ in Philadelphia during the week of January 10. Present program schedules call for Wednesday and Sunday motion picture broadcasts and Friday evening remote pick-ups from the Philadelphia sports arena.

For the job that must be done

★ By the thousands, Simpson Instruments are going forth to assume vital responsibilities in America's march to victory—to help do the job that must be done. ★ You will find them in active service on the fighting fronts—maintaining vital communications, and keeping watch over the men and machines that carry the battle to America's enemies on land and sea and in the air. ★ On the home front they are helping importantly in the production of planes, tanks, ships and guns.

SIMPSON ELECTRIC COMPANY, 5200-5218 Kinzie Street, Chicago, Illinois

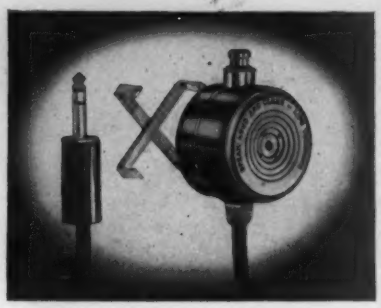
Simpson

INSTRUMENTS THAT STAY ACCURATE

★ ★ ★
BUY WAR BONDS AND STAMPS FOR VICTORY

NEW PLASTIC MODEL

MICROPHONES



NEW, modern plastic models of the CU-1 aircraft microphone and the new 1700 type at about half the weight of former models, give crisp, clear, clean speech. Use of plastics affords full insulation and complete freedom from corrosion. Beautiful to the eye and pleasant to feel. Also jacks, switches, parts, and plugs PL-68, PL-54, PL-55, JK-26, JK-48 and PL-291 (companion plug), and SW-141.

UNIVERSAL precision in workmanship, material and scientific engineering. These vital items in our war effort have been time tested . . . in the air, on and under the sea and on land . . . on our home fronts and battlefields.

Available to U. S. prime and subcontractors and friendly foreign countries. Priorities, required.

DELIVERY

IMMEDIATE initial shipment; balance of order in ample time to meet all schedules.

•

EXPORT . . . Bert Hassler (Frazar and Co.), Annapolis Hotel, Washington, D. C.

Universal Microphone Co. Ltd.

INGLEWOOD CALIF. U. S. A.

Nikola Tesla Dies

THE DEATH OF Nikola Tesla in a New York hotel suite on January 7 closes the career of a man known throughout the world as the "electrical wizard," for his invention of the Tesla induction coil, the induction motor and more than 900 other electrical devices for which patents were issued.

Nikola Tesla was born at Smiljan, Yugoslavia on July 9, 1856 (some authorities say 1857). He first saw Z. T. Gramme's electric dynamo armature at the polytechnic school at Graz, Austria, and later succeeded in simplifying this dynamo. He attended the University of Prague for two years, worked for the telegraph engineering department of the Austrian government, invented a telephone repeater, built his first electric motor in Strasbourg, worked as electrical engineer in Budapest and Paris, watched Lord Rayleigh conduct experiments in London, and emigrated to the United States in 1884. With four cents in his pocket as he came off the boat at the Battery, he walked up Broadway, encountered a gang of workmen trying to fix an electric motor, and fixed it himself for a fee of $20. After working for some time with Thomas A. Edison in West Orange, N. J. on the design of motors and generators, he left to form the Tesla Electric Co. of New York. Then came a flood of inventions—a practical system of arc lighting in 1886, the third-brush method of regulating dynamos, his history-making alternating current induction motors which had no commutators or brushes (in 1888), and in 1891 the famous Tesla coil or transformer. In 1893 Dr. Tesla developed a wireless system for transmitting intelligence, and followed this with mechanical oscillators and generators of high-frequency currents. About 1894 he announced the discovery of cosmic rays. Researches and discoveries in the field of radiant energy occupied his time from 1896 to 1898.

After about 1900, Nikola Tesla's ideas bordered increasingly on what many considered the fantastic. His researches in the transmission of power through the air cover the period from 1897 to 1905. As early as 1908 he announced experiments with interplanetary communication. Plans for harnessing the sun's rays, the energy of the sea, the heat inside the earth and the temperature di ferential of ocean levels have ma headline news in newspapers in cent years, as also did his ann ounc ment seven years ago of a dea beam powerful enough to destr armies and airplanes.

An official state funeral was giv him under the auspices of the Yug slav Government-in-Exile, with ser ices at the Cathedral of St. John t Divine in New York City. Amo the honorary pallbearers were Dav Sarnoff, E. H. Armstrong, Dr. E. Alexanderson, Gano Dunn, Willia J. McGonigle, William H. Barton a Dr. H. C. Rentschler.

Idle Electric Motors Needed

ALL PURCHASERS desiring new el tric motors must now certify th they have no idle motors which c be adapted for the desired purpo that they have attempted to obta used motors from at least thr sources, that the motors are n quired for immediate use, and th the motors are not being purchas for replacement purposes. Th ruling in WPB General Conserv tion Order L-221 is intended to p every usable electric motor to wo producing war materials, and ke manufacture of new motors at minimum. About 95 percent of t weight of a motor is made up four critical basic materials—iro steel, aluminum and copper, and t remaining 5 percent consis largely of mica, shellac and equal scarce materials.

WPB urges that surplus new a used electric motors be sold imm diately to war plants or used equi ment dealers, or at least listed wi WPB's General Industrial Equi ment Division. One function this division is to assist purchase in locating hard-to-find types used motors.

Mycalite Becomes Mykroy

ELECTRONIC MECHANICS, INC. a nounce that their insulating ma rial formerly known as Mycalite now called Mykroy. The latter na was assigned to the product when was found that the original na conflicted with two similar tra names in related fields.

Mykroy is made by Electronic M chanics, Inc., 70 Clifton Blvd., Cl ton, N. J. D. E. Replogle is the pre dent of the concern.

FERRANTI ELECTRIC

☆

Transformers - Reactors

IDEAS WANTED

for Peace-time Products

● If you have an idea for an electronic or radio product which can be placed on the market after the war is over, *we want to hear from you.*

Today our factory is busily engaged in making communications devices for America's armed forces. But we are looking forward to the time when the world will again be at peace and will be in a position to buy a larger number of products than ever before. We believe that *now* is the time to get busy on post-war planning—and we invite you to come along with us.

We will pay a good price for worth while ideas on new products and developments. Please tell us what you have in mind. Send your letter to Max L. Haas, President, Bud Radio, Inc., 2118 East 55th St., Cleveland, Ohio.

BUD RADIO, INC.
CLEVELAND, OHIO

On the Sea...
PINCOR Products
Keep 'Em Winning!
DYNAMOTORS • CONVERTERS • GENERATORS • D.C. MOTORS • POWER PLANTS • GEN-E-MOTORS
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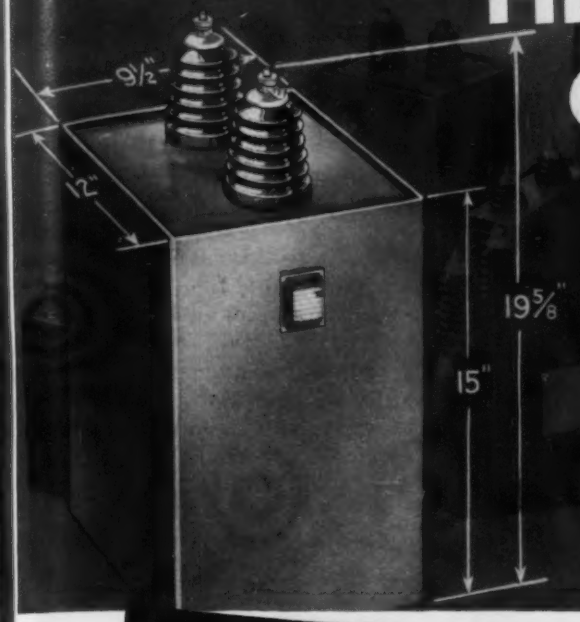
Philips Works in Holland Is Seriously Damaged By Bombs

GERMAN-HELD PLANTS of the Philips Incandescent Lamp Works at Eindhoven, Holland have been bombed by United Nations fliers in a low-level Sunday noon attack planned to injure as few as possible of the Dutch workers in and near the plants. News dispatches indicate that both the lamp and tube factory on Emmasingel Avenue in the town and the radio receiver factory and glass works at Stryp outside the town were seriously damaged if not completely destroyed. The Eindhoven plants were erected at a cost of more than $60,000,000, and cover a total area of 78 acres.

A number of Philips executives and engineers, including P. F. S. Otten, President, came to the United States in 1940, and are now operating several American Philips factories. These plants are now producing electronic equipment for the U. S. Army and other United Nation military needs. Similar Philips plants are operating in the British Empire. All plants outside Holland are held in trust for the original owners. The original Dutch company, N. V. Philips' Gloeilampenfabrieken, now has its main office at Willemstad, Curacao, Netherlands West Indies.

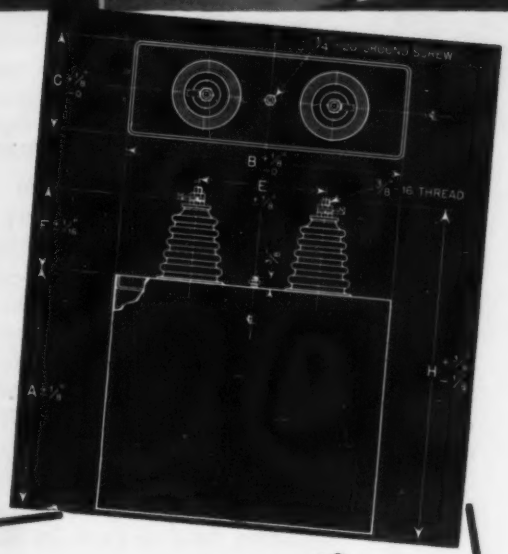
BRIGADIER GENERAL PAUL W. BAADE issues orders to troops somewhere near Salinas, Puerto Rico, over a walkie-talkie radio system. The telephone handsets used with this equipment are one of the many articles manufactured for the U.S. Army Signal Corps by the Kellogg Switchboard and Supply Co. Photo by U.S. Army Signal Corps

HIGH-VOLTAGE CAPACITORS



50,000 Volts
FOR INTERMITTENT SERVICE
-- surge generators, etc. --

To 30,000 Volts
FOR CONTINUOUS SERVICE
-- rectifier filters, etc. --



AEROVOX TYPE '20

TYPE 6020—6000 v. D.C. Work.
2.0 mfd. to 10.0 mfd.

TYPE 7520—7500 v. D.C. Work.
0.5 mfd. to 6.0 mfd.

TYPE 10020—10,000 v. D.C. Work.
1.0 mfd. to 5.0 mfd.

TYPE 12520—12,500 v. D.C. Work.
0.5 mfd. to 5.0 mfd.

TYPE 15020—15,000 v. D.C. Work.
0.25 mfd. to 3.0 mfd.

TYPE 20020—20,000 v. D.C. Work.
0.25 mfd. to 4.0 mfd.

TYPE 25020—25,000 v. D.C. Work.
0.2 mfd. to 1.0 mfd.

TYPE 37520—37,500 v. D.C. Work.
0.1 mfd. to 1.0 mfd.

TYPE 50020—50,000 v. D.C. Work.
0.1 mfd. to 0.5 mfd.

also 25,000 v. Output (12,500-12,500 v.) for Voltage-Doubler Circuits
0.25-0.25 mfd. to 0.5-0.5 mfd.

● To meet certain radio and electronic developments, Aerovox engineers have developed the Hyvol Type '20 oil-filled capacitors covering voltage ratings from 6000 to 50,000 v. D.C.W. Already many of these capacitors are in military service.

Giant, AEROVOX designed and built winding machines handle up to several dozen "papers." Likewise a battery of giant tanks permit long pumping cycles for thorough vacuum treatment, followed by oil impregnation and filling, of the sections. The multi-laminated kraft tissue and hi-purity aluminum foil sections are uniformly and accurately wound under critically controlled tension to avoid mechanical strain.

The sections are *connected directly across the full working voltage.* In the higher capacity units, a plurality of sections are *connected in parallel.* These capacitors are not to be confused with the series-connected sections heretofore frequently resorted to in attaining high working voltages. Furthermore, due to the use of Hyvol dielectric oil, these capacitors maintain their full rated capacity even at freezing temperatures. Hermetically-sealed in sturdy welded steel containers. Rustproof lacquer finish. Cork-gasketed pressure-sealed glazed porcelain high-tension pillar terminals.

Submit that Problem . . .

Regardless, whether it be for a giant high-voltage capacitor or a low-voltage by-pass electrolytic, send along that problem for our engineering collaboration, recommendations, quotations. Engineering literature on request.

NEW BEDFORD, MASS., U. S. A.
Sales Offices in All Principal Cities

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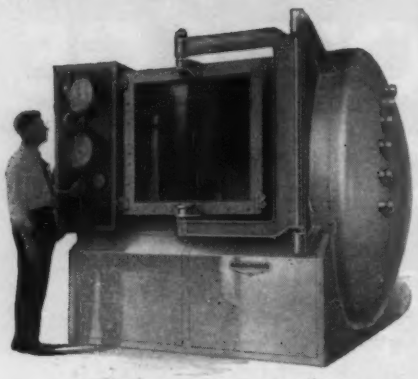
AEROVOX CANADA LTD.
Hamilton, Ont.
EXPORT: 100 Varick St., N. Y.
Cable 'ARLAB'



Bring the Stratosphere
"Down to Earth" with
KOLD-HOLD

Test all types of aircraft instruments with this KOLD-HOLD Stratosphere unit in a fraction of the time that would be required waiting for "natural" stratosphere conditions. Now, you can "bring the stratosphere down to earth" at will, and SEE the performance of the instruments under pre-determined levels of pressure and temperature.

Performance of moving parts of some instruments and devices may be observed and charted by use of a stroboscopic beam directed on the product through the Thermopane panel. Such tests enable the manufacturer to test not only his products but viscosity of lubricants used.

Regardless of your testing requirements, make KOLD-HOLD your headquarters for stratosphere data. Capacities, temperature ranges, conditions of pressure, and controls can be engineered to meet your specific needs.

Send now for NEW Catalog No. 431, or for specific data covering your particular requirements.

NEW YORK — 254 W. 31st — Penn. 6-1161
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KOLD-HOLD MANUFACTURING CO.
446 N. Grand Ave., LANSING, MICH., U.S.A.

FCC Actions

TRANSFER OF CONTROL of the Yankee Network from John Shepard, 3rd and George R. Blodgett to the General Tire and Rubber Co. of Akron was approved by the FCC on December 31, 1942. The property includes standard broadcast stations WNAC in Boston, WEAN in Providence, WAAB in Worcester and WICC in Bridgeport, f-m station W43B with transmitter at Paxton and W39B with transmitter atop Mount Washington, and four relay stations. The sale price is $1,240,000, plus an additional amount to be determined on the date of transfer and equal to 94 percent of the net quick assets over $100,000.

HALF-INTEREST IN WEMP in Milwaukee was sold with FCC approval for $50,000 to a syndicate of six men, comprising Senator Robert A. La Follette; Leo T. Crowley, Alien Property Custodian; James Markham; Dr. W. Nesbitt, Madison physician; William B. Dolph, executive vice-president of WOL in Washington; Herbert L. Pettey, director of WHN in New York. The remaining half-interest remains in the hands of Glenn Roberts, a Madison attorney.

THE FREQUENCIES OF 6370, 11,145 and 13,050 kc. have been assigned to the international broadcast service. These had previously been assigned to Radiomarine Corp. of America for coastal telegraph service. Two additional frequencies, 7805 and 7935 kc., have also been assigned to international broadcast service, but zone and interzone police communication on these two frequencies will still be permitted since police communications occur during daylight hours when interference would not be expected.

FCC LICENSES have been granted for two relay stations serving regular broadcast stations. WLAB gets a power of 30 watts on 31,630, 35,260, 37,340 and 39,620 kc for use with WRVA in Richmond. WAAD gets 100 watts on 1,646, 2,090, 2,190 and 2,830 kc for use with WFTL in Ft. Lauderdale, Fla.

CONTROL OF KOCY in Oklahoma City was transferred with FCC consent from M. S. McEldowney to Plaza Court Broadcasting Co. for $30,000.

RCA Combines

RCA MFG. Co., wholly-owned subsidiary of Radio Corporation of America, was combined with the parent company on Dec. 31, 1942. The manufacturing organization will be known as the RCA Victor Division of Radio Corporation of America. No changes are contemplated in management, personnel, operations or sales policies. In announcing this change, RCA President David Sarnoff stated, "The unification of the administrative, research and manufacturing activities of RCA will result in closer coordination and increased flexibility of operation. It is expected that this unity and coordination of services will facilitate the company's war efforts."

George K. Throckmorton, former chairman of the executive committee of RCA Mfg. Co., has been elected a vice-president of Radio Corporation of America.

Military Capacitors Exempt from Price Control

EXEMPTION OF FIXED RADIO capacitors from price control when intended for military use has been extended from Jan. 1, 1943 to April 1, 1943. In announcing this extension, OPA pointed out that production of capacitors for military equipment has not yet reached the desired point of stability for purposes of price regulation.

Civilian Instructors in Radio Needed in South Dakota

BOTH MEN AND WOMEN are urgently needed as Radio Instructors at the Army Air Forces Technical School in Sioux Falls, South Dakota. Starting salaries range from $1620 to $2600 a year. Minimum requirements include a high school education (even this may be waived in some cases) plus any one of the following education-experience groups: (1) One year of experience as a radio repairman, radio operator or radio engineer; (2) An amateur or commercial radio operator's license held now or recently held; (3) Successful completion of a six-month resident course in radio or an ESMDT radio course; (4) One year of college work.

X-Ray Inspection Permits Use of Die Castings for Fuses

ALUMINUM DIE-CASTINGS made by certified producers are now eligible for a WPB "superior specification" if x-ray examination is provided for the entire run of sample castings and for a specified number of random samples taken from the production run. High-power x-ray apparatus, having not less than 1,400,000-v. capacity, is specified to make sure that even the smallest internal flaws and cracks will be revealed. X-ray inspection will permit the use of the die-casting process for ammunition components such as bomb and shell fuses, making possible production rates as high as 4000 pieces per hour.

Supreme Court to Review Marconi Patent Suits

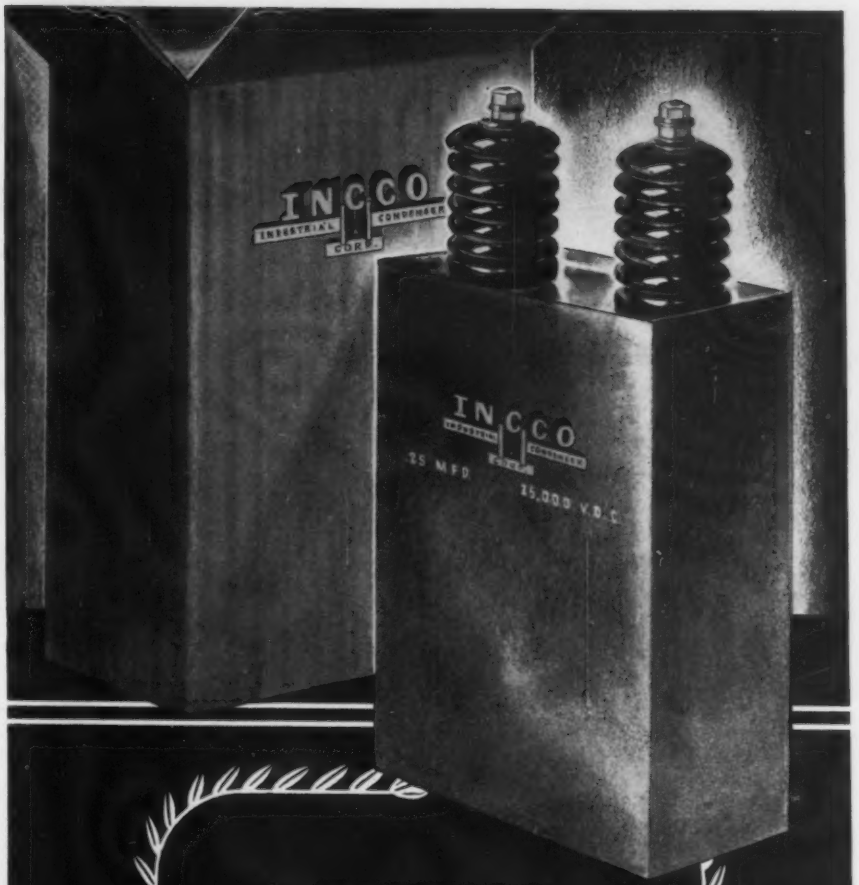
THE U. S. SUPREME COURT has agreed to review the final patent infringement suit of the Marconi Wireless Telegraph Co. against the United States. This controversy originally involved Marconi patents for antenna devices and the fundamental radio patents of Sir Oliver Lodge and Sir John Ambrose Fleming. The patents have been involved in court actions since the years before the first World War.

Batteries for Hearing Aids Are Scheduled

PRODUCTION OF TWO TYPES of A batteries and four types of B batteries for hearing aids has been authorized by WPB as a result of a recently-completed simplification and standardization program for hearing aids. These standard sizes of batteries will have to serve more than 175 varieties of hearing aids, previously requiring 56 types of A batteries and about 175 types of B batteries.

Plant Branch of Signal Corps Moves to Philadelphia

THE PLANT BRANCH in the Office of the Chief Signal Officer, entrusted with the installation, maintenance and repair of Signal Corps equipment for the largest single communications network in the world, is being moved from Washington to Philadelphia. The new location will be in the vicinity of the Philadelphia Signal Supply Depot.



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PAPER, OIL AND ELECTROLYTIC CONDENSERS

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DISTRICT OFFICES IN PRINCIPAL CITIES
QUICK DELIVERY FROM DISTRIBUTOR'S STOCKS

KENYON

"KNOW-HOW"

IS *Successfully* MEETING
THE TOUGHEST TRANSFORMER
SPECIFICATIONS

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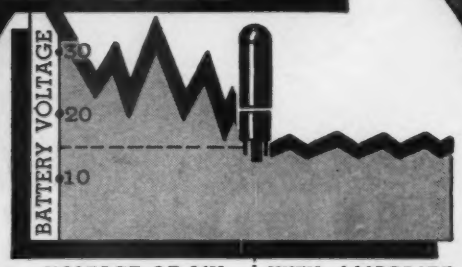
840 BARRY STREET NEW YORK, N. Y.

Solve Voltage Variation
PROBLEMS IN AIRCRAFT, TANKS, ETC.
WITH
AMPERITE
BATTERY CURRENT & VOLTAGE REGULATORS

Features:—
1. Amperites cut battery voltage fluctuation from approx. 50% to 2%.
2. Hermetically sealed — not affected by altitude, ambient temperature, or humidity.
3. Compact, light, and inexpensive.

Now used by U. S. Army, Navy, and Air Corps.
Send us your problem.



VOLTAGE OF 24V BATTERY & CHARGER VARIES APPROX. **50%**
WITH **AMPERITE** VOLTAGE VARIES ONLY **2%**

AMPERITE COMPANY • 561 Broadway, New York, N. Y. Cable: Alkem, New Yor
In Canada: Atlas Radio Corp., Ltd., 560 King St. W., Toronto

Congress Relaxes Provisions of Communications Act

PROVISIONS OF THE Communications Act affecting ship and aircraft radio have been waived or relaxed by Congress for the duration of the war, to give the Navy greater discretion in handling maritime communications. Under the new measure, the Navy directs the transmission of reports relating to positions of ships, and directs radio operations of foreign ships in U. S. waters. Peacetime equipment requirements are waived to permit movements of vessels in emergencies without specified radio equipment or operators. Emergency military messages can now be given priority over distress messages. Members of the armed forces may now operate ship and aircraft radio stations without licenses. The relaxation of the operator's license ruling is considered especially beneficial to test and ferry pilots.

Radiophoto Service Started Between U. S. and China

PRESS WIRELESS INAUGURATED the first radiophoto and facsimile radiocommunications service between this country and China on Dec. 15, 1942 by sending to Generalissimo Chiang Kai-shek in Chungking a letter personally written to the Generalissimo in handwriting by President Roosevelt. One hour was required for delivery of the President's letter. The new radiophoto circuit provides a direct connection between Chungking and the Los Angeles stations of Press Wireless.

Bendix Aviation Opens New Electronic Research Department

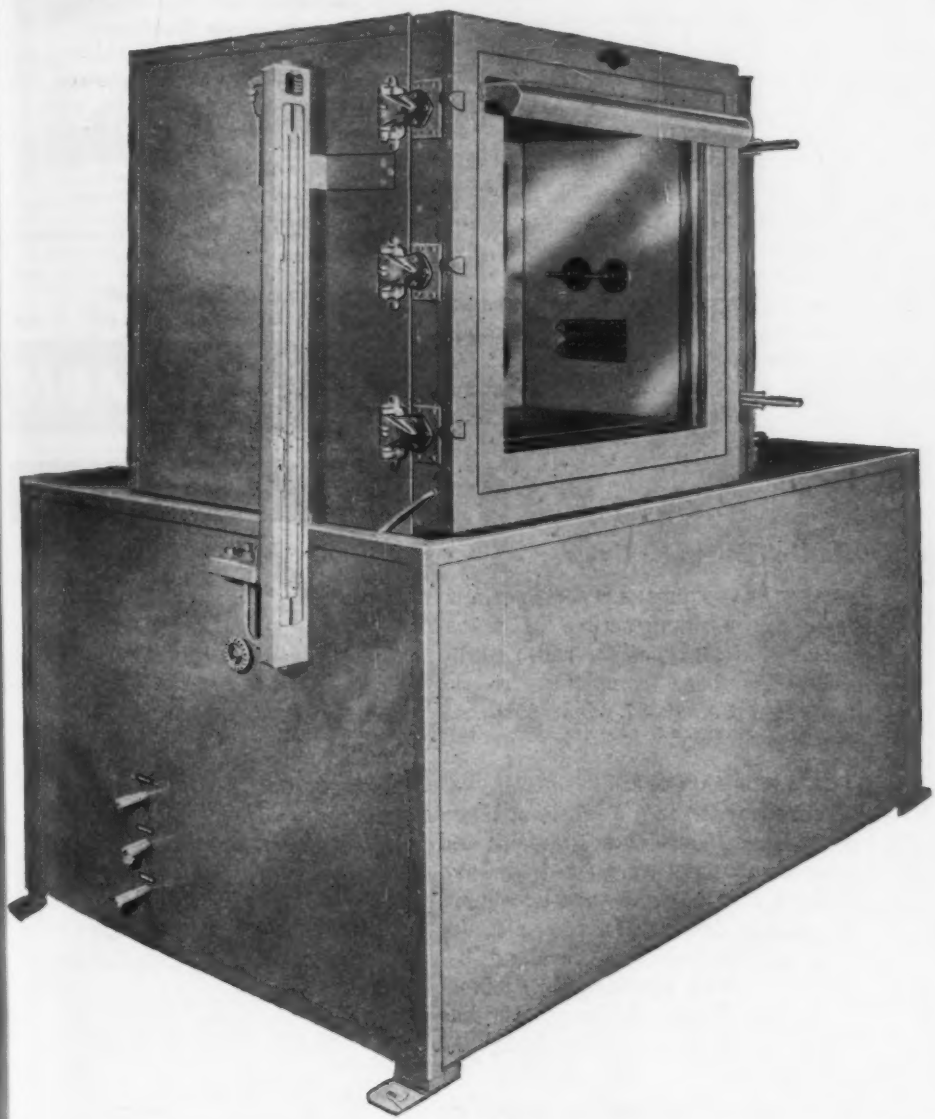
A NEW DEPARTMENT devoted to exploring advanced uses for radio and electronic equipment has been set up in North Hollywood by Bendix Aviation, Ltd. Delmar Wright has been named director of research, with Frank McCullough as his associate. They will be assisted by Dr. Sydney Weinbaum, former member of the faculty of California Institute of Technology. George Warr is engineer, and Frederick Lemm is assistant engineer.

Production Testing

under a full range of **High Altitude** conditions

Test-proved parts and equipment are necessary . . . when performance counts. MOBILE high altitude test and calibration chambers meet the production test requirements of the Air Corps. Whenever standard models are not suitable, chambers can be designed to specifications. Within the ranges and limits mentioned, we can supply your requirements . . . and make possible better and more efficient testing of vital equipment.

All of our units incorporate positive automatic means of refrigeration and control, with an indicating recording controller. The chamber sizes listed below indicate clear inside test space only.



★

High Altitude Development Chambers

Temperature: —100° F to +180° F.
Vacuum: to .5" Hg absolute.
Time: complete cycle within 90 minutes.
Size: minimum of 12" x 12" x 12" to any greater capacity.
Humidity: 20% to 95% R. H. manual or automatic control.

★

Cold Chambers

Specifications are identical with those listed for altitude chambers, except that cold chambers have no vacuum provision.

★

Hot and Cold Bath Calibration Stands

Temperature: —85° F. to +600° F.
Control: constant temperature control ±1° F.
Size: 1 pint to 50 gallons; also available with multiple vat units.
Automatic mechanical refrigeration (no dry ice).

★

Flight Chambers

Temperature: to 100° F. or without refrigeration.
Vacuum: to 80,000 ft. with automatic control of temperature compared to pressure.
Size: 6' x 4' x 4' to as large as 10' x 10' x 50'.
Humidity: manual or automatic control in range between 20% and 95% R. H.

★

Accessory Instruments

Special Recording Pyrometers
Manometers and Altimeters
Vertical Speed Indicators
Oximeters
Instrument panels and switchboards

May we assist you with your problem?

MOBILE REFRIGERATION INC.

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"dag"
COLLOIDAL GRAPHITE

ITS PROPERTIES

An electrical conductor
Low in photoelectric sensitivity
Diamagnetic
A black body
Low coefficient of expansion
Gas absorbent
Opaque
Chemically inert
A conductor of heat

ITS USES IN ELECTRONICS

Vacuum tubes
Ray focusing anodes in cathode ray tubes
Shields
Grids, radio
Plates, radio
Electron guns
Nonmetallic electrodes
Glow discharge tubes
Luminous gaseous discharge lamps
Experimental cells
Converter and output tubes
Electron multipliers
Half wave rectifiers
Three element discharge devices
Photoelectric cells
Counter electrodes
Resistances
Thermopiles

ACHESON
COLLOIDS CORPORATION
PORT HURON "dag" COLLOIDAL PRODUCTS MICHIGAN

Research Awards Dropped for Duration of War

THE RESEARCH FELLOWSHIPS which have been awarded annually for the past five years by Westinghouse to deserving young scientists have been discontinued for the duration of the war. These fellowships enabled students to continue their studies at the Research Laboratories of the company in East Pittsburgh. Pure research as such is now carried out by Westinghouse only where it can help the war effort, and all facilities are concentrated on getting the war job done as quickly and efficiently as possible.

Westinghouse officials state that the ability of its research laboratories to contribute to the war effort is being restricted by a shortage of highly trained men. They therefore invite correspondence with men who in normal times would be interested in a research fellowship, with the thought that some can best aid the war effort as members of the Westinghouse research or production staffs. Correspondence should be addressed to the Manager, Technical Employment and Training, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Radio Business News

A NEW TRANSFORMER PLANT specializing in the manufacture of transformers of all types for radio equipment has been completed by the Langevin Co. at 37 West 65th St., New York City.

THE DETROLA CORP. of Detroit was acquired by Strong, Carlisle & Hammond Co. of Cleveland. Ill health and retirement plans were cited by John J. Ross, former owner and president, as reasons for making the sale. Joseph J. Stephens of Cleveland becomes the new president of Detrola Corp., and Roger M. Daugherty has been named president in charge of engineering.

ELECTRONIC ENTERPRISES, INC., 67 Seventh Ave., Newark, N. J., enters the electronic manufacturing field, and will specialize in transmitting tubes and electronic devices needed in the war effort. O. H. Brewster is Treasurer and General Manager, and J. H. Wyman is Director of Engineering.

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Everything you need in *Electronics* and *Radio* is available from this one central source. Our large, complete stocks of over 15,000 items speed delivery. Our experienced staff solves your problems. Write, wire, or phone *Haymarket 6800*.

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RARE GASES AND MIXTURES

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Scientific uses for Linde rare gases include—
1. The study of electrical discharges.
2. Work with rectifying and stroboscopic devices.
3. Metallurgical research.
4. Work with inert atmospheres, where heat conduction must be increased or decreased.

Many standard mixtures are available. Special mixtures for experimental purposes can be supplied upon request.

The word "Linde" is a trade-mark of
THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 E. 42d St., New York UCC Offices in Principal Cities
In Canada: Dominion Oxygen Company, Ltd., Toronto

Signal Corps Gains Six Generals

TWO NEW MAJOR Generals and four new Brigadier Generals have been nominated in the Signal Corps by President Roosevelt and approved by the Senate.

James A. Code, Jr. becomes the youngest Major General in the Signal Corps, being only 49 years of age. The promotion is in recognition of his resourcefulness and ability in assisting Major General Dawson Olmstead, Chief Signal Officer.

Harry C. Ingles was likewise promoted from Brigadier General to Major General. General Ingles has had distinguished success in establishing communications networks and developing Signal Corps activities overseas, particularly in the Panama Canal Zone.

The four Signal Corps men promoted from the rank of Colonel to Brigadier General are: David McLean Crawford, Director of the Communications Coordination Division in the Office of the Chief Signal Officer; Richard B. Moran, now on an overseas assignment; Henry L. P. King, Chief of the Military Personnel Division of the Signal Operations Service in the Office of the Chief Signal Officer; Frank C. Meade, Director of the Planning Directorate of the Office of the Chief Signal Officer.

First Underground Phone Cable Crosses Country

COMPLETION OF A 1600-mile run of buried cable between Omaha and Sacramento in December, 1942 gives to the United States its first completely underground transcontinental telephone cable. According to Walter S. Gifford, President of A.T.&T., the decision to complete an underground connection was made in 1939 because of the possibility of a war with Japan. Underground construction is a guarantee against interruption of service by wind, sleet or formation of ice, and greatly adds to the dependability of wartime communication. The completion of the underground line gives a total of five lines crossing the western part of the United States by different routes. The other four lines are open wires, however, carried overhead on telephone pole cross-arms.

Photo by U. S. Army Signal Corps

HERE TRANSFORMERS *MUST* BE TOUGH!

When tanks roll into action only the toughest transformers can give the uninterrupted service so vitally essential. Transformers built to the rigid standards of the United States Army Signal Corps have the qualities necessary for constant performance under these conditions.

The Chicago Transformer Corporation has had long experience in the manufacture of transformers that meet these requirements as well as the rigorous tests that have originated in our own laboratories.

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CORPORATION

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RESISTORS · CONDENSERS · CONTROLS · WIRE
TRANSFORMERS · CABLE · HEADPHONES · RELAYS
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• Dalis Service has meant SPECIALIZATION in meeting radio and electronic parts requirements since 1925. The great number of items obtainable from ONE source has saved untold money, time and trouble for thousands of Dalis customers.

That SPECIALIZATION is today even more significant in expediting priority orders. Ample stocks on hand provide immediate shipment in many instances. And if items are not in stock Dalis gets them to you in the shortest possible time.

Let Dalis SPECIALIZED SERVICE help you fill your urgent priority needs, with maximum efficiency, minimum delay.

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Vital Statistics

ALLOTMENT OF COPPER for the Bell System has decreased progressively from 8,000 tons per month in the fall of 1941 to 1000 tons in December, 1942. For 1943 it is reported that the Bell System has been allocated 87 tons of copper, with no assurance that the metal will actually be available. By utilizing available new and used materials with maximum possible effectiveness, however, Bell System has been able to place more than 1,100,000 additional telephones in service in 1942 and expand many other services. Cable laid for military establishments and other government war projects contained nearly 17 billion feet of wire. In addition, nearly three million circuit-miles of toll facilities were placed in service in 1942.

DURING 1942 the Signal Corps distributed contracts for over $4,000,000,000 of communications equipment. Other major accomplishments for the year include expansion of communications facilities overseas as well as in this country and its territories and possessions, and construction of communications facilities along the Alcan Highway.

TOTAL BACKLOG on prime radio equipment contracts at the end of November 1942 amounted to $2,967,167,000, according to the year-end report on war production by WPB Chairman Donald M. Nelson. Actual production of equipment by the radio industry in November is valued at $160,000,000.

DESPITE THE FACT that 13,000 Western Electric men joined the various armed services in 1942, the total personnel of Western Electric Co. was increased by 15,000 in that year. Approximately 75,000 are now employed, of which 32,000 are women.

APPROXIMATELY 160,000 persons are today taking pre-employment training for war industry jobs, and an equal number of employed workers are taking supplementary training outside of working hours in preparation for better jobs. Any U. S. Employment Service office will refer applicants to the proper agency at which training can be secured for available jobs in a particular locality.

OVER A BILLION pounds of aluminum were produced in the United States during 1942, and the 1943 peak of production is expected to give this country a capacity of over two billion pounds a year. Increases in aluminum production have brought corresponding reductions in price. At the beginning of this World War, aluminum ingot sold for 20 cents a pound, but the price today has come down to 15 cents a pound. Most of the aluminum in this country is produced by Alcoa in its own plants and those leased from the government.

DOLLAR VOLUME of deliveries to Signal Supply Services for November showed an increase of 30.5 percent over October. The November Signal Corps figure represents an increase in dollar volume of 1328 percent over January, 1942.

AUTOMATIC ELECTRIC CO.
Chicago, Illinois

CINAUDAGRAPH CORP.
Stamford, Conn.

DEJUR AMSCO CORP.
Shelton, Conn.

THE DOW CHEMICAL CO.
Midland, Mich. (Two awards for production which has been, in some instances, double the capacity of the plant.)

MEISSNER MFG. CO.
Mt. Carmel, Ill.

MONSANTO CHEMICAL CO.
Organic Chemical Division of Monsanto Plant, Monsanto, Ill.

RADIO RECEPTOR CO., INC.
New York, N. Y.

STROMBERG-CARLSON TELEPHONE MANUFACTURING CO.
Rochester, N. Y.

THERMADOR ELECTRICAL MFG. CO.
Los Angeles, Cal.

VARD INC.
Pasadena, Cal.

WALLACE & TIERNAN PRODUCTS, INC.
Belleville, N. J.

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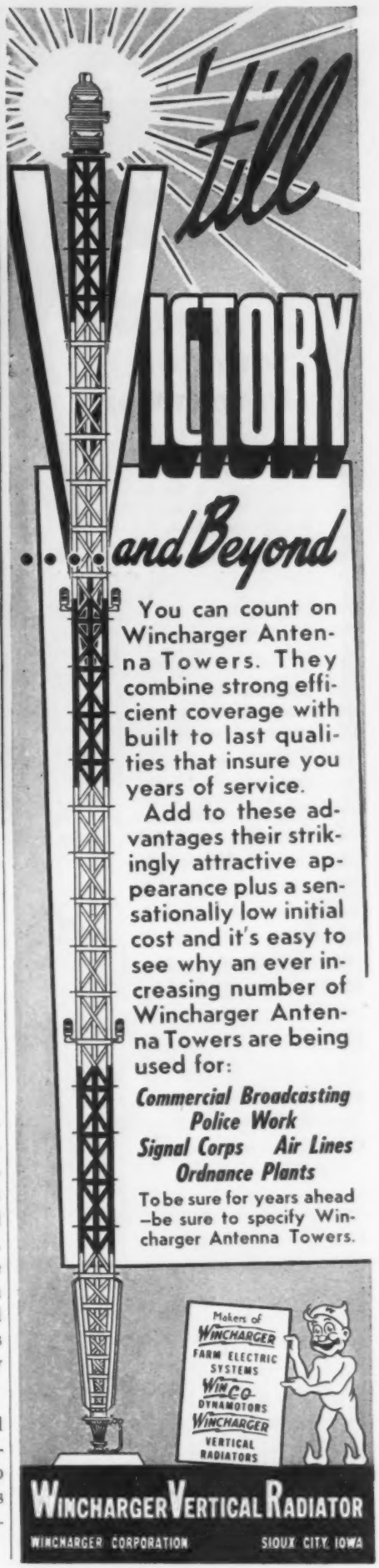
WINCO
GIVES YOU
ALTI-TEMP
DYNAMOTORS
WINCO DYNAMOTOR
Where complete dependability is essential . . . where efficient electric power is important . . . specify WINCO DYNAMOTORS! WINCO DYNAMOTORS are built for all types of service . . . for operating temperatures ranging from —40° to +65° Centigrade.
COMPACT
LIGHT WEIGHT
MINIMUM A.C. RIPPLE
LOW VOLTAGE REGULATION
These are only a few of the quality features in WINCO DYNAMOTORS.
WINCO DYNAMOTORS are regularly available in standard outputs and sizes . . . special WINCO DYNAMOTORS can be designed to meet your exact need. Our complete free Advisory Engineering Service is yours without obligation —why not consult us?
The Dynamotor designed to insure maximum efficiency at all operating altitudes and temperatures.
WINCO DYNAMOTORS
WINCHARGER CORPORATION
SIOUX CITY IOWA

Bernard H. Sullivan, Manager of Sales for the Westinghouse Lamp Division, Bloomfield, N. J., has been assigned responsibility for all commercial activities involving lamps and special products, and Ralph C. Stuart has been appointed Manager of Manufacturing and Engineering for the Division. The announcement follows the death of David S. Youngholm, Vice President in charge of the Lamp Division, who died recently from a sudden heart attack.

The Late David S. Youngholm

Ellery W. Stone, for the past three years Executive Vice-president of Postal Telegraph, Inc., was elected President at a meeting of the board of directors recently. Edwin F. Chinlund, whom he succeeds as President, remains Chairman of the Board and of the Executive Committee and will devote his efforts to effecting the proposed merger of the telegraph companies. Mr. Stone was President of the Federal Telegraph Company from 1924 to 1931. He joined the Postal Telegraph organization in 1938 as Vice President. He is a Fellow of the I.R.E.

Leslie J. Woods has been named Vice President and General Manager of the National Union Radio Corp., Newark, N. J., manufacturers of radio tubes and electronic devices.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VICTORY
. . . and Beyond
You can count on Wincharger Antenna Towers. They combine strong efficient coverage with built to last qualities that insure you years of service.
Add to these advantages their strikingly attractive appearance plus a sensationally low initial cost and it's easy to see why an ever increasing number of Wincharger Antenna Towers are being used for:
Commercial Broadcasting
Police Work
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To be sure for years ahead —be sure to specify Wincharger Antenna Towers.
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SIOUX CITY, IOWA

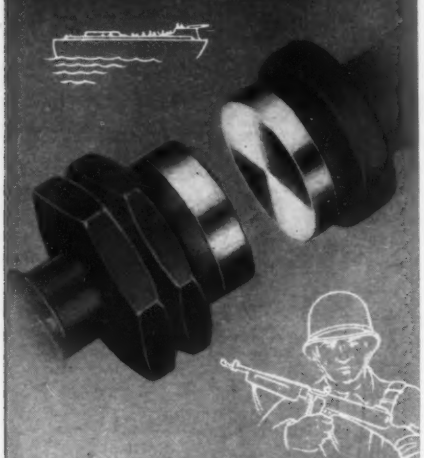
COMMANDOS
and
TUNGSTEN

. . . have something in common!

Alert, ready for instant action, taking tough assignments in their stride, bearing the brunt of aggressive force—that's the job of the Commandos . . . and the function of tungsten contacts.

Heavy service loads at the flick of a control, unceasing operations day after day, high speed opening and closing. All come under the heading of specifications. Intangibles, such as the elimination of operation loss caused by film coatings adhering to contact surfaces, are taken for granted.

That's why METROLOY contacts can be depended upon for aggressive action in your future sales campaigns. Metroloy Company, 53-55 E. Alpine Street, Newark, New Jersey.



METROLOY
TUNGSTEN PRODUCTS

NEAREST TO RESISTANCE FREE OPERATION

Henry L. Crowley & Co., West Orange, N. J., announces the appointment of Earl S. Patch as Mechanical Engineer in Charge of Application Engineering. Mr. Patch was formerly associated with General Motors Co.

Roger M. Wise, for more than ten years chief radio engineer of Sylvania Electric Products Inc. (formerly Hygrade Sylvania Corporation) has been advanced to the position of Director of Engineering. He

is the first to occupy the new post. Expanded activity in the field of electronic devices for war uses made it necessary to coordinate all of Sylvania's engineering problems under one head. Mr. Wise joined the company as a radio engineer in 1929, and later became chief radio engineer. When war work enlarged the company's scope and output Mr. Wise was made General Manager of Operations for special and large radio tubes last June. He will continue this supervision.

William Wilson has retired from his job at the Bell Telephone Laboratories after twenty-eight years of service. His retirement was brought about by a prolonged illness. Dr. Wilson joined the research group of Western Electric Company's Engineering Department at a time when transcontinental wire telephony had just been accomplished; when its interest in electronics was increasing, and when radio telephony was just inside the horizon. His education was marked by honors and accompanied by scholarships. It was when he entered Cambridge that he had the formative opportunity of working under Sir J. J. Thompson, a pioneer in electronic investigations. Dr. Wilson's first work in the Bell Laboratories was a mathematical investigation of the vacuum tube, which Dr. H. D. Arnold had developed from the audion of Lee deForest. His work at the Laboratories over a period of years included vacuum-tube research as well as radio research until 1927 when he became Assistant Director of Research. In 1934 he was also placed in charge of the research work on wire communication. Later in 1936, in the reorganization which accompanied the appointment of Dr. Jewett to Chairman of the Board and of Dr. Buckley to the Presidency of the Laboratories, Dr. Wilson was appointed Assistant Vice-President in charge of the departments of Personnel and Publication from which he now retires. He was active in the A.I.E.E. and particularly the I.R.E. where he served as a member or chairman of various committees. He was also a member of the executive committee of the American Section of the International Scientific Radio Union.

Frederick C. Young, who has just been named Vice President in Charge of Engineering of the Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y.

Dr. **H. A. Jones,** manager of sales of General Electric electronic tubes for non-communication applications, has been commissioned a lieutenant-Colonel in the U. S. Army Signal Corps. He has reported for duty with the Research and Development Division of the Signal Corps, with an office in the new Pentagon Building, Arlington, Va.

John Rosevear, veteran engineer of twenty year's service, has been appointed staff assistant in the Industrial Engineering and Equipment Department of the Westinghous Lamp Division, Bloomfield, N. J. In his new position, Mr. Rosevear will help coordinate activities of the recently organized department which deals with problems of tooling and the development of new manufacturing processes.

Albert C. Delmont has been appointed Research Director of the newly-organized research and laboratory departments of the Douglas & Sterling Co., management consultants, of Stamford, Conn. The new department has been established to investigate the manufacturing capacity of industries, and the adaptation of present or new products to the equipment and capacity of companies looking forward to post-war-markets. Mr. Delmont was engaged in consulting work on Naval ordnance production before taking his new position. He is a graduate of M.I.T., and has served as a member of the Standardization Committee of the American Railway Association.

D. R. Guthrie has been appointed Personnel Manager of the Ward Leonard Electric Co., Mount Vernon, N. Y.

Charles G. Pyle, General Sales Manager of Sylvania Electric Products Inc., (formerly Hygrade Sylvania Corporation) has been appointed Managing-Director of the National Electrical Wholesalers Association.

Leo Edelson, for the past ten years Development Engineer for Handy & Harmon, has joined the staff of Induction Heating Corp., New York City, specialists in the application of high frequency currents for use in brazing, melting, hardening, heating and annealing.

BEST TOOLS KEPT HERE

Some of America's most famous companies will tell you that we have exceptionally excellent facilities for precision manufacturing. That's right! But, we maintain that our very best tools are 54 years of "Know What" and "Know How."

When you, too, need Metal Fabrication: Precision Machine Work: Electrical and Mechanical Assembly—"Let Lewyt Do It." Our carefully engineered methods and closely coordinated production controls enable you to shoulder us with the entire production responsibility for a complete product—or a single part. This "Packaged Production" may deliver the best answer to your war production problems and peacetime plans. Prior commitments permitting!

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CORPORATION

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Only SOUNDSCRIBER

gives you

PERFECTED EMBOSSED GROOVE
SOUND RECORDING and REPRODUCTION

Scientifically compensated, embossed groove recording eliminates chips and shavings, gives unattended, trouble-free operation, and *permanent* needle points.

Plus these 4 other features

1. Excellent communications *fidelity*.
2. Proved constant *angular* velocity.
3. Thirty minutes on a 7" plastic disc, using both sides.
4. Virtually indestructible discs, only .010" thick, mailable, fileable, non-warping.

THOUSANDS USED BY WAR PLANTS, THE ARMY AND NAVY

THE BASIC SOUNDSCRIBER CHASSIS

The SOUNDSCRIBER Corporation
82 Audubon Street, New Haven, Conn., U. S. A.

DESIGNED FOR DISCRIMINATING MANUFACTURERS

Leakproof
ENAMELED
MAGNET
WIRE

A product, resulting from many years of research in the field of fine wire manufacture, that meets the most rigid requirements of radio and ignition coils. A new coating method gives a smooth, permanently-adherent enameling, and mercury-process tests guarantee perfect uniformity. Great flexibility and tensile strength assure perfect laying, even at high winding speeds. If you want reduction in coil dimensions without sacrificing electrical values, or seek a uniform, leakproof wire that will deliver extra years of service, this Hudson Wire product is the answer.

QUALITY
UNIFORMITY
SERVICE

Also manufacturers of high grade cotton and silk covered wires, cotton and silk coverings over enamel coated wires, and all constructions of Litz wires. A variety of coverings made to customers' specifications, or to requirements determined by our engineers. Complete design and engineering facilities are at your disposal; details and quotations on request.

Winsted
HUDSON WIRE CO.
Division
WINSTED • CONNECTICUT

Flux Navigator

(*Continued from page* 77)

The dominant audio frequency component of the electromagnetic field was found to be 180 cycles, with of course lesser products due to the multiples of 60 cycles. This makes the audio characteristic of the amplifier well defined.

Experimental Amplifier Design

No attention need be given to waveform distortion and the amplifier is designed for maximum voltage gain per stage. The arrangement shown in the block schematic of Fig. 6 develops a voltage gain of approximately 17,000 with the values given. This is much more than adequate for this application and permits greater induction field sensitivity when required. The output load circuit (see Fig. 7) consists of a differential microammeter, with a full scale deflection of 1 milliampere. It connects in series with 50,000 ohms and full scale deflection requires 0.050 watts (50 milliwatts). A square law vacuum tube voltmeter has been found superior to diodes for cable indication. Because it meets the circuit requirements and only draws 150 ma filament current at 6 volts, the 6W7G tube, was chosen for the circuit. Vibration in the boat militates against the use of the more fragile 1.5 volt tubes.

In the single loop arrangement only one channel of the two shown in Fig. 7 is required. The completed form of this type of indicator is shown installed on shipboard. All batteries are contained within the case.

In reporting this work, it is hoped that what has been given here in the practical sense may be of use to others with a similar problem. The author wishes to express his appreciation and indebtedness to Mr. E. K. Cohan, CBS Director of Engineering, Mr. Henry Grossman, CBS Eastern Division Engineer, and Mr. Gene Fubini, Engineering Department, for their encouragement and suggestions. Thanks are also due to the members of the Island staff who assisted in the experimental work, and to Mr. O. W. Read, Transmitter Supervisor, under whose direction the development work was conducted.

War and Radio Standards (Cont. from p. 57)

to the enemy for it must be manufactured and transported although it is doing nothing for the effort, and it takes its toll of overhead and bookkeeping. The reduction in the number of different types in a given piece of equipment is a first step to a solution of this problem. The further ability of swapping among the services in the field with assurance that the borrowed part is the proper one should make an Army radio operator on Guadalcanal much happier over a capacitor he gets from a battleship.

At first thought, one would expect the Army to have different conditions from the Navy and that a single design would result in increased manufacturing costs in time and material in providing a capacitor to meet the extremes of all the services. However, second thought shows that while the Navy has always roamed the world, meeting a wide range of conditions, the present conflict is global and the Army and the other branches will be found from the tropical islands of the Pacific to Alaska. No piece of radio equipment may be designed with safety for service in any specific place. The demands are so urgent and varied as to make any prediction dangerous.

Only air-borne equipment undergoes trials beyond those met by apparatus used on the surface of the earth. Air pressure being much reduced at high altitudes, electrical insulation and moisture proofing must be given special attention. Fortunately, the mica capacitor can be designed to meet these additional requirements without unduly increasing the manufacturing problem. This permits a single design for all purposes.

Of the many hundreds of physical sizes of capacitors available as a result of peacetime design, a group of 22 has been selected to care for all demands from handy-talkies to the largest transmitters.

Molding facilities and some materials being sharply limited, no design which molds a small capacitor in a relatively large case has been approved. Each physical size of case is packed to its upper safe limit and the capacitance range continued in a larger case when that is necessary. Similarly, uneconomical manufacture such as molding a relatively large unit in a small case with the resulting increased shrinkage in production, is avoided. This is a common complaint in these days when the overall size and weight of apparatus is so important. If the designer insists on such a unit, he must prove the need in order to justify specification of a nonstandard part.

Many months are required to make new models and so the standard sizes of capacitors have followed the existing practices in order to avoid such troubles. Molds for nonstandard sizes will be used for replacement of such capacitors now in service.

While it would be illogical to expect these wartime standards to be carried over into peacetime manufacture because the conditions of use of the components differ so greatly, particularly in relation to temperature range, there will undoubtedly be some unification on physical sizes and ranges of electrical values. In addition, the opportunity for the specialists to discuss their problems around a table will have a marked influence on all production and cannot help but improve the quality of the components.

• • •

NEW TRANSMITTING PLANT

During September, KMPC, of Beverly Hills, California dedicated its 10,000-w transmitting plant. Shown in the photo is B. H. Linden, head of Los Angeles FCC office, L. C. Sigmon, chief-engineer of KMPC and Dr. Lee de Forest, inventor of the three electrode vacuum tube

The impelling necessity for war production will truly be reflected in the post war period by vastly improved communication systems, both in radio and television equipment.

In the future people will enjoy the luxury of these ultra modern communications through Harvey-Wells experience gained in war production . . . the instrument will be more compact — homes will enjoy them . . . all cars will have them . . . factories will use them . . . boats, planes and trains will demand them . . .

However, at the present time we pledge ourselves to see that our war jobs are delivered on time and to the best of our individual efforts.

★

HARVEY-WELLS COMMUNICATIONS

ARE HELPING TO WIN THE WAR

★

HARVEY-WELLS *Communications inc.*

★

HEADQUARTERS

For Specialized Radio Communications Equipment

SOUTHBRIDGE, MASS.

NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs. Each month descriptions of these new items will be found here

"Multiform" Process Glass Parts

Glass Articles Molded By New "Multiform" Process

THE CORNING GLASS WORKS has perfected a new method of fabricating glass articles. It is known as the "Multiform" process. The technique permits fabrication of intricate shapes not readily produced by conventional methods involving the blowing, pressing or drawing of hot glass. It is particularly applicable to the manufacture of coil forms, tube sockets, co-axial line beads and other insulating parts requiring a high order of accuracy with respect to positioning and dimensions of flanges, grooves and holes.

Briefly describing the manufacturing process, and in contrast with customary glass-making methods, the Multiform process employs a combination of cold-molding batch materials and subsequent fusing to attain the shapes, perforations, grooves and threads not usually attainable by hot-molding. Finished work is translucent or opaque in appearance due to the presence of occluded gasses in the glass, but when examined in cross-section, parts precisely resemble articles made by conventional hot-blowing, pressing or drawing methods. The result of the Multiform process is still glass.

Parts could be made clear or transparent if applications warranted such expense but this is not contemplated at the present time. Like glass made by conventional methods, products fabricated by the new process may be ground, polished and drilled but it is obviously better practice to avoid the necessity for such work by proper mold design. Seals may be made to materials having appropriate coefficients.

The Corning laboratory has data on some 25,000 varieties of glass. Approximately 300 varieties are actually used in the firm's plants in the course of an average year. Most of these glasses can be fabricated by the new process if the need arises but at the present time it appears desirable to confine production to types which lend themselves best to the process and to current physical and electrical needs. Components parts are therefore being fabricated of four basic types of glass, the characteristics of which are given in the accompanying table. Type 790 combines the properties of very low thermal expansion, resistance to high temperatures, chemical durability and low dielectric loss. This particular glass, relatively new as to type, is 96 percent silica and has a coefficient of expansion not much greater than that of fused quartz. Types 7761 and 707 have low dielec-

COMPARATIVE PROPERTIES OF CORNING GLASSES MADE BY CONVENTIONAL AND "MULTIFORM" PROCESSES

Glass Type	790		7761		707		774	
Mfg. Process	Conv.	Mult.	Conv.	Mult.	Conv.	Mult.	Conv.	Mult
Density	2.18	2.15	2.16	....	2.13	2.10	2.23	....
Soft. Temp. (°C)	1500	....	....	....	745	....	820	....
Max. Op. Temp. (°C)	900	800	500	500	425	425	500	....
Lin. Exp. (0–300 C) (per °C x 10^{-7})	7.8	8.5	28	....	31	32	32	....
Water Abs. (24 hrs.) (%)	None	<0.01	None	<0.01	None	<0.01	None	....
Mod. of rupture (lbs/sq.in. x 10^3).								
— annealed	....	5	10	7	10	7	10	....
— spec. process	....	....	18	....	18	12	18	....
Volume Res. (ohms per cm. cube)								
log R at 20°C	13.5	....	....	....	17.0	....	14.7	....
log R at 250°C	9.7	9.3	12.3	....	12.1	....	8.1	....
log R at 350°C	8.1	7.8	10.2	....	10.1	....	6.7	....
Dielectric Strength (volts/mil)	high > 500		high > 500		high > 500		high	
S.I.C.(20°C)								
60 cps	4.5	....	....	....	3.95	....	4.80	....
1 kc	....	....	....	....	3.95	....	4.70	....
1 Mc	4.0	4.0	4.0	4.0	3.95	4.0	4.65	....
10 Mc	....	....	....	....	3.99	....	4.65	....
60 Mc	4.0	....	....	....	3.70	....	4.20	....
3000 Mc	....	....	....	....	....	....	4.89	....
P.F.(20°C) (%)								
60 cps	0.065	....	....	....	0.06	....	1.27	....
1 kc	....	....	....	....	0.06	....	0.77	....
1 Mc	<0.05	0.18	0.09	0.11	0.06	0.10	0.42	....
10 Mc	....	....	....	....	0.07	....	0.41	....
60 Mc	0.076	....	....	....	0.076	....	0.54	....
3000 Mc	....	....	....	....	....	....	0.89	....
L.F. (20°C) (%)								
60 cps	0.29	....	....	....	0.24	....	6.08	....
1 kc	....	....	....	....	0.24	....	3.62	....
1 Mc	<0.20	0.72	0.36	0.44	0.24	0.40	1.95	....
10 Mc	....	....	....	....	0.23	....	1.91	....
60 Mc	0.30	....	....	....	0.23	....	2.27	....
3000 Mc	....	....	....	....	....	....	4.40	....

TUBES REBUILT

★

Our vastly increased production facilities are now prepared to serve the broadcasting industry

*ALL TYPES OF TUBES FROM 250 WATTS**

GUARANTEE—1000 HOURS—PRORATA BASIS

REBUILDING CHARGE—75% OF LIST

**Our past records indicate that approximately 87% of all tubes received were successfully rebuilt.*

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There are many technical developments that we wish we could tell you about now. When the war is won, you will be able to see them in the finest equipment National has ever built.

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tric losses and can be used as insulation at extreme frequencies. Type 774, fabricated by conventional processes, has been used for many years in the manufacture of power and radio insulators, fuse tubing and bushings. It will be noted that the electrical and physical characteristics of parts made by the new cold-molding technique compare favorably with those of parts fabricated from the same base material by conventional hot-blowing, pressing or drawing operations.

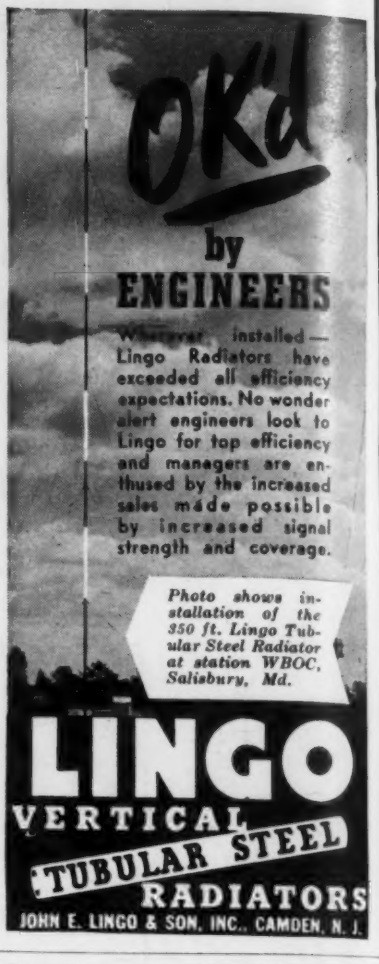
The cost of parts made by the Multiform process is, according to the manufacturer, competitive with that of parts made of high-grade steatites.

Cathode Ray Oscilloscope

MODEL 555, cathode-ray oscilloscope is designed for use where extended frequency measurements are required. The oscilloscope uses a 5-inch cathode-ray tube which operates at 2000 volts. Maximum voltage at input voltage to terminals of the amplifier is 600 volts d.c., and direct to deflection plates is 500 volts, rms. The input resistance is 3 megohms. Frequency response is ±3 db from 20 cps to 2 megacycles. Voltage amplification is approximately 275.

The frequency range of the sweep signal generator is from 30 cps to 350 kc. Measurement of the unknown peak voltage, accomplished by a comparison method using an internal voltage source, is made on a direct indicating multirange voltmeter. The instrument operates from standard 115-230 volt, 50-60 cps, power lines. It is supplied with a non-corrosive steel case 14 inches high, 12 inches wide, and 19 inches deep.

Radio City Products Co., Inc., 127 West 26th St., New York, N. Y.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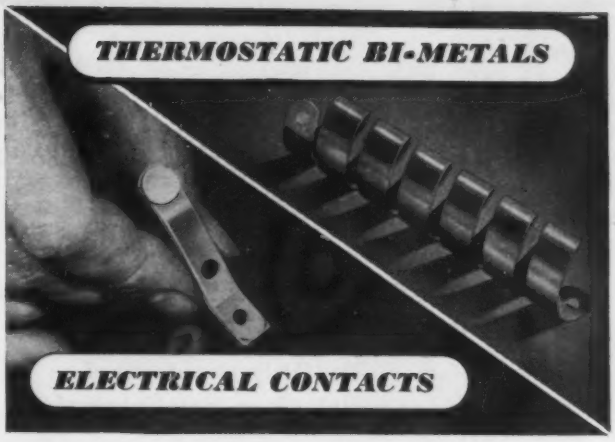
ILLUSTRATED IS THE "Super-Chief" model, a new line of the manufacturer's inter-communication systems, utilizing new features which the manufacturer calls "conference traffic control." This control system enables any number of stations to hold a private conference without interruption or eavesdropping from other stations outside of the conference group. Another feature is a one-way automatic transmission system, especially effective for the dictation of letters and for complete recording of conferences. The instrument

utilizes finger-tip pushbutton control. The amplifier of the unit delivers an undistorted output of 5 watts and permits operation with other units as far as 3000-feet from each other. Each station is equipped with individual volume control so that incoming volume may be adjusted to suit individual requirements. Earphones are available, if desired. "Super-Chief" models are available in systems consisting of from two to ten, twenty, thirty, forty, sixty or eighty stations.

Talk-A-Phone Mfg. Co., 1219 West Van Buren St., Chicago, Ill.

Portable Recording Oscillograph and Accessory

TYPE 5-101 PORTABLE RECORDING oscillograph is a compact unit (measuring 18 inches long, 13 inches wide, and 12 inches high, and weighing 70 pounds) which will record as many as fourteen signals at one time. Records can be made in any lengths since a paper knife is built into the instrument for cutting paper when removing the records to be devel-



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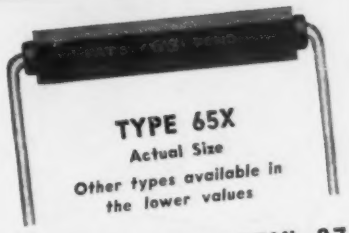

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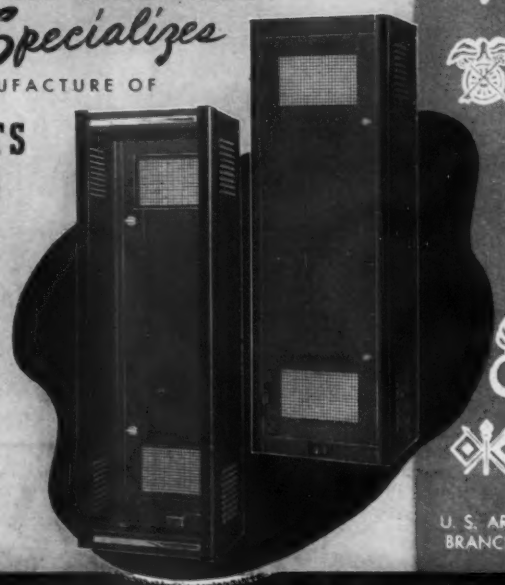

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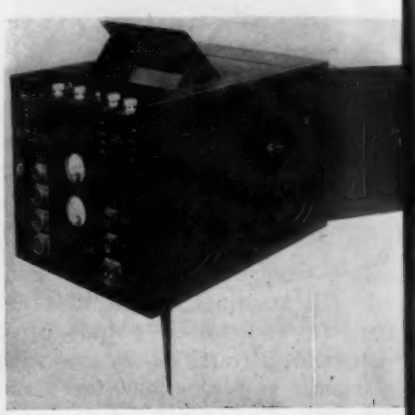
PAR-METAL PRODUCTS CORPORATION

32-62—49th STREET . . . LONG ISLAND CITY, N. Y.

Export Dept. 100 Varick St., N. Y. C.

oped, or for perforating the paper between records. The signal traces are recorded on an 8-inch photographic paper which is 200-feet in length. Any one of three paper speeds may be selected when recording. These speeds are normally 4, 8 and 16-inches of paper per second, but the oscillograph can be furnished with any three speeds in a 1-2-4 ratio up to 12½, 25 and 50-inches per second. When the oscillograph is in operation, a footage meter on the front panel shows the number of feet of unexposed paper remaining. The magazines are loaded and unloaded in the darkroom, while the loading and unloading of the oscillograph with the recording paper may be done in daylight. Timing lines while recording are spaced at intervals of 0.01 second and are photographed with the trace record. A single switch records, numbers and titles two records.



A voltmeter is built into the front of the oscillograph for use when checking and adjusting the various operating voltages. By means of a circuit selector switch, the voltage at all critical points can be determined.

The instrument is designed to take any number of galvanometer elements up to fourteen. Four different galvanometer types are available to cover various frequency ranges of measurement. The sensitivity and frequency range of each galvanometer when used with the instrument are as follows: Type 7-101, frequency range, 0-50 cps, sensitivity 5.0 inches ma, resistance, 14 ohms, electric damping; Type 7-102, 0-1000 cps frequency range sensitivity 0.02 inch ma, resistance, 3 ohms, oil damping; Type 7-103, 0-750 cps, sensitivity 0.04 inch ma, resistance 3 ohms, oil damping; Type 7-104, frequency range 0-200 cps, sensitiv-

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ity 0.14 inch ma, resistance 6 ohms, electric damping. A thermostatically controlled heater maintains the temperature around the galvanometers at between 70 and 80 deg. F. (independent of outside temperature) to hold sensitivity and damping constant. The entire instrument is shock mounted to prevent mechanical vibrations from damaging or upsetting the behavior of the unit. Operation of the oscillograph may be either by local or by remote control.

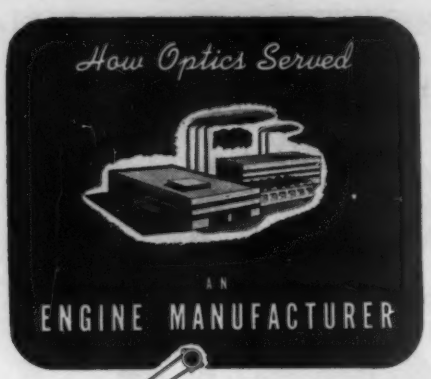
A unit designated as Type 11-102 remote control is available for use with the oscillograph described above. With it the oscillograph can be operated at a distance since a 25-foot cable with connector plugs is

Consolidated Engineering Corp., 1255 E. Green St., Pasadena, Cal.

Standby Automatic Transfer Switch

DESIGNED TO ELIMINATE interruption and lag in the transfer of a load from normal to emergency service is a new improved automatic transfer switch for use in broadcasting stations, theatres, hospitals or any place where more than once source of current is available and where continuous lighting is necessary. It is so designed that all contacts are carried on one shaft, and operate in the same direction. The contacts are either in the normal or in the emergency position at all times and there is no "off" position. The unit will operate with any combination of electric power supplies.

One magnet frame, with the coil connected to the normal supply line, holds the normal contacts closed and the emergency contacts open during normal operation. On failure of the



SOME engine pistons have hollow castings of intricate interior construction. Even after the most careful flushing, particles of sand from the casting core sometimes remain to make trouble. And serious trouble it is, for when the sand is washed out by the engine's lubricant, it is very likely to score cylinder walls and produce a serious breakdown.

When this problem was presented to Perkin-Elmer engineers, it took just twelve days to design and produce a device which, according to the engine manufacturer, has completely overcome this danger. It is a relatively simple optical instrument, similar to a physician's bronchoscope, enabling inspectors to explore every piston web and pocket. Stray particles of sand are quickly located and removed.

The ways in which the Science of Optics can serve Industry are innumerable. When you have a production problem in which optics might supply a solution, we should be pleased to have you write us. Today our engineering and manufacturing facilities are devoted entirely to the war effort, but if we could help you now, or later on, we should welcome the opportunity.

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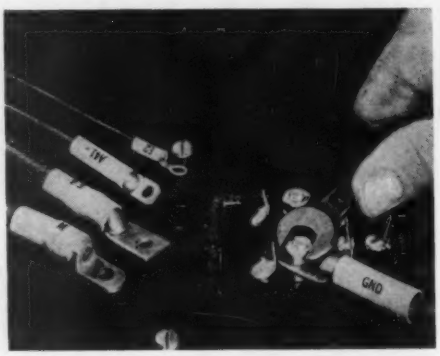
normal service the normal contacts open by gravity, and the emergency contacts close by means of individual compression springs on each contact. On resumption of the normal service the magnet closes the normal contacts and opens the other sources of supply. The switch can be set for timed automatic supply when that is desirable.

The switch is compactly mounted on an ebony asbestos panel and is readily accessible. It is available in 1, 2, 3 and 4-pole types, and in eighteen capacities ranging from 30 to 600 amps.

Zenith Electric Co., 152 W. Walton Street, Chicago, Ill.

Combination Insulator and Wire Marker

EXTRUDED PLASTIC TUBING which can be clearly marked with letters or numerals of customer's choice are available in short lengths to serve as insulators of terminal connections and as wire markers. The tubing is designed to speed up assembly by eliminating any additional means of identification in applications where lug insulation and wire identification are required. Smooth inside surfaces

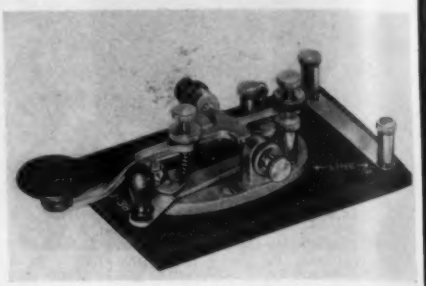


permit quick application over wires and lugs. The tubing from which these are made has high dielectric strength and the ink which is used to mark the tubing is resistant to chemicals, water and oils. The tubing comes in colors with either black or yellow symbols, and in ASTM sizes from No. 9 to $\frac{3}{8}$ inch inside diameter. Larger sizes are available on specification.

Tubing of plastic materials, which can be printed and utilized solely as wire markers, is also available from the manufacturers, Irvington Varnish & Insultator Co., 6 Argyle Terrace, Irvington, N. J.

Telegraph Key

MODEL J-38, telegraph key, is a sturdily built sending instrument which is equipped with a shorting lever for receiving. Hard rubber insulating washers are of laminated-grade bakelite instead of rubber. The frame of the key is made of solid casting, and the shorting lever is made of nickel plated brass. The key lever is stamped from $\frac{1}{4}$-inch



thick alloy steel. Grade XX black bakelite is used in the mounting base. Pure coin silver is used in the contacts. An eyelet in the base of the key prevents the phone cords from pulling loose.

Models J-44, J-45 and J-37 are also available from American Radio Hardware Co., 476 Broadway, New York, N. Y.

Decade Resistance Box and Wheatstone Bridge

TYPE DR, d-c resistance decades are available in standard models with resistance ranges of 0.9 to 999,999 ohms total, in two price classes. Coils are of manganin wire, except the 100,000 ohm coils which are of Nichrome. All coils are bifilar-wound on ceramic tubes, oven-baked and protectively-coated. Switches

have self cleaning multiple blade phosphor-bronze spring wipers. The instruments are housed in rubbed walnut cases.

WHEATSTONE BRIDGE (TYPE RN-1) contains four resistance dials with nine positions each, covering 9x1, 9x10, 9x100, and 9x1000 ohms, with decade multiplying dials. The ratio resistances have a guaranteed accuracy of ±0.05 percent, while the resistance coils in the decades of the bridge are guaranteed to ±0.1 percent tolerance. Specifications for

switches and cabinet are the same as for the decade boxes already described. The galvanometer is of a moving-coil type with a sensitivity of 1 microamp. per division. Three standard flashlight cells comprise the 4½ volt battery in the cabinet, readily accessible without removing the panel. External battery connections are also provided.

Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.

Reversing, Dynamic Breaking Contactor for Aircraft

MODEL CR2791-Q100 is a new three-purpose contactor designed to start, reverse, and provide dynamic braking for d-c split-field, series-wound aircraft motors. It is applicable to motors having full-load currents up to 10 amps and locked rotor currents of 60 amps at 12 or 24-volts, d.c. The new contactor is compact and light in weight and combines in one unit the functions of several single-purpose relays, including interconnections and mechanical interlocks. All moving parts are statically and dynamically balanced. The contactor is corrosion proof and can be

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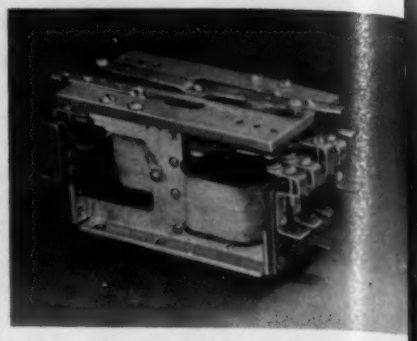
NATIONAL UNION RADIO Corp. 57 STATE STREET, NEWARK, NEW JERSEY



mounted in any position on either a metallic or non-metallic base.

Other features of the contactor include operation at rated currents in ambient temperatures ranging from 95 deg. C to −40 deg. C and at altitudes up to 40,000 feet. It will also withstand 95 percent humidity at 75 deg. C on 48-hour tests, with immediate operation thereafter. A balanced-armature construction assures that when the relay is in either the energized or de-energized state the contacts will remain in their open or closed position even when subjected to mechanical frequencies of 5 to 55 cps at $\frac{1}{32}$-inch maximum amplitude ($\frac{1}{16}$-inch total travel) applied in any direction, or when subjected to a linear acceleration of 10 times gravity in any direction.

General Electric Co., Schenectady, N. Y.

Fibre Conduit as Substitute for Metal

"BERMICO" IS THE NAME of a fibre conduit of wood cellulose fibres built up and heat-treated to form rugged tubes with a solid homogeneous wall structure. These tubes are then impregnated to produce a chemically inert, light-weight pipe with high mechanical strength and water resistance. Non-critical materials

are used through its manufacture. Bermico has been used mainly in the installation of electrical cables but is now being used as casing in shallow oil wells.

Samples of this fibre conduit are available from the manufacturer, Brown Co., 500 Fifth Ave., New York, N. Y.

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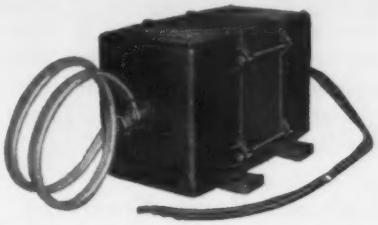
Testing Transformer

TYPE T-4173 isolating transformer is designed to eliminate all interference that would affect the testing of equipment for Signal Corps or other service branch use. Secondary terminal connections are provided by means of a lead shielded cable, the sheath of which is integrally joined to the copper enclosing shield of the secondary winding.



The manufacturer claims that the isolating transformer, normally rated at 2 kva is capable of handling an over-load of 50 percent. The regulation of the transformer is 1 percent at 1 kva. Instruments or equipment may be used as the need requires, the load being switched on and off without affecting the relatively constant voltage necessary for accurate testing.

The Acme Electric & Mfg. Co., Cuba, N. Y.

Aircraft Relay

THE MANUFACTURERS of "Diamond-H" switches announce a new solenoid type (25 amp) aircraft relay which is built to conform to U. S. Army Air Corps specification for Type B-2A relays. The new relay features a rigid cap which is designed to protect the relay from dust and to reduce the danger of mechanical damage. The unit which supplements the manufacturers aircraft relay line is for use in the remote control of aircraft sub-assemblies such as fuel pumps, landing lights and various controls.

Hart Mfg. Co., Hartford, Conn.

Pencil Tracing Cloth

A TRACING CLOTH called "Penciltex" is available in roll sizes of 20 yard lengths and width sizes of 30, 36 or 42 inches. Cut sheets are also available. The cloth is very transparent and takes a jet-black line from the hardest pencil.

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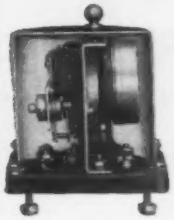

Type TD 2
surface
mounting
back or front
connection

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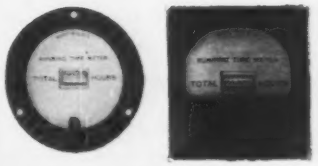
Type TD4
Moisture Proof
Front connected

Type CC 105-1
Panel Mounting
front connected

Bulletin No. 700-2

also

Elapsed Time Meters

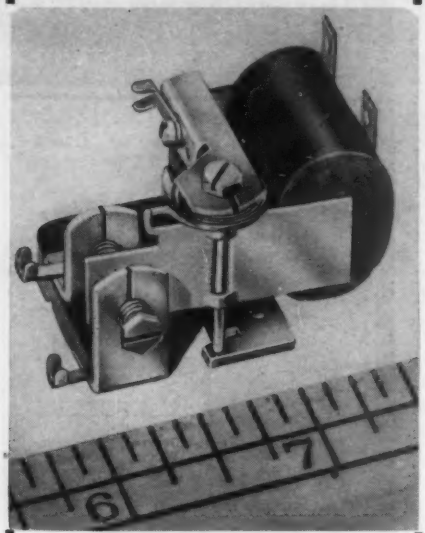


These meters are for panel mounting. They are essential to check tube life.

Bulletin No. 3500

The R.W. CRAMER COMPANY Inc.
CENTERBROOK CONNECTICUT

SIGMA SPECIALISTS IN Electronic Control



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Varflex Corporation, Insulation Specialists, Rome, N. Y.

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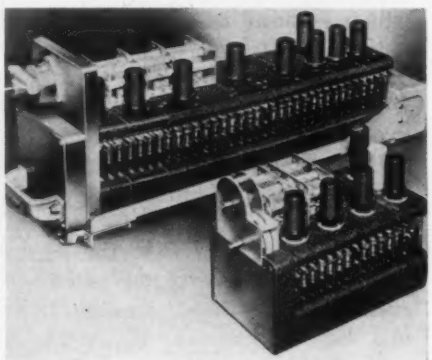
A METHOD OF assembling communications receivers from three basic cells, all using just one type of tube, is announced by the Electronics Division of Harvey Machine Co., Los Angeles. The three types of cells produced in quantities are r-f units, i-f units and a-f units. Practically any type of receiver can be assembled from four or more of these previously-constructed cells. As an example, a receiver such as is used in scout cars would be made up by assembling two r-f cells, one i-f cell and one a-f cell on a group of busbars which connect the cells together both electrically and mechanically. For an aircraft receiver having four



frequency bands and provisions for direction finding, nine cell units might be used.

One outstanding military feature of Harvey Unitized Construction is the fact that a damaged cell can be completely replaced by an unskilled operator without a soldering iron or a circuit diagram. Only one type of spare tube need be carried in stock, as it will fit in any cell unit. The cells are built to meet military requirements in all respects.

Literature

Resistors and Relays. Bulletin 23 contains general information, and mounting dimensions, ratings, sizes, and number of steps of Vitrohm strips resistors. Bulletin 104 gives general information, features, contact data and prices of midget metal base relays. Bulletin 23 and 104 available from Ward Leonard Electric Co., Mount Vernon, N. Y.

Interchangeability Chart. Tubes that are completely interchangeable and tubes which might be used interchangeably with mechanical or electrical design changes are given in bulletin 6922, "G-E Electronic Tubes for Industry." Available from General Electric Co., Schenectady, N. Y.

Heats of Certain Gases. Bulletin No. 30 entitled "The Specific Heats of Certain Gases Over Wide Ranges of Pressures and Temperatures" gives physical data for air, carbon dioxide, carbon monoxide, ethylene, hydrogen, methane, nitrogen and oxygen. Equations are given which determine the effect of pressure on the specific heats of the gases, within ranges of temperature and pressure encountered most frequently in engineering practice. The variations of specific heats with temperature and pressure are also shown graphically. Single copies may be obtained free, additional copies sent to the same person are fifty cents each. Engineering Experiment Station, Cornell University, Ithaca, N. Y.

Pivot Manual. Bulletin No. 40 is a complete pivot manual covering specific and technical data on the application of long life Premium alloy pivots as used in all types of instruments. The alloy properties and physical properties are also given. Request should be addressed to The Paraloy Co., 600 S. Michigan Ave., Chicago, Ill.

Automatic Control Equipment. Bulletin No. 720 describes and illustrates magnetic contactors, remote control switches and automatic transfer switches. Price lists are included for each. Available from Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Precision Instruments. This booklet describes the available types of precision instruments for the exacting inspection of internal surfaces. Briefly described are the various types of industrial telescope, pocket battery box, safety battery box, diagnostic light controller and endoscopic camera. Copies available from American Cystoscope Makers, Inc., 1241 Lafayette Ave., New York, N. Y.

Electrical Resistance. Typical characteristics of negative resistance materials are given in a folder of general information and suggested applications. The various types of coefficient resistors are illustrated by blue prints. The booklet is made up in loose-leaf form so that supplemental information may be added. Keystone Carbon Co., Inc., Saint Mary's Pa.

Radio Formula and Data Book. A handy pocket-sized handbook of the most frequently used mathematical formulas, tables, data and standards in the field of radio and electronics, has been edited by Nelson M. Cooke, chief radio electrician, U. S. Navy. For reference are formulas, tables and data covering Ohms' law; induc-

tance; reactance; impedance; resonance; use of exponents, trigonometric relationships, logarithms, radio color codes, abbreviations, mathematical symbols, wire tables, etc. Formulas pertaining to meters and vacuum tubes are also included. The price is ten cents per copy available from Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.

Lathe Operation. Circular No. 21-C describes briefly motion picture films, instruction books, bulletins, wall charts and blue prints on lathe operation. Several other booklets are offered as an aid in the training of lathe operators. South Bend Lathe Works, South Bend, Inc.

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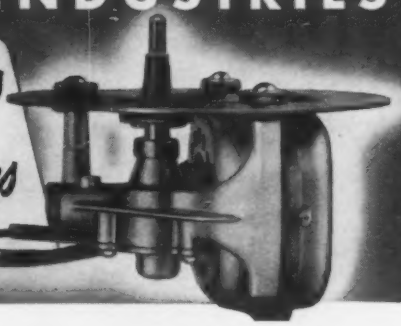

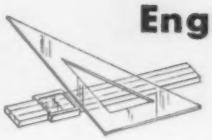

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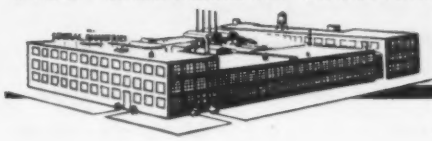

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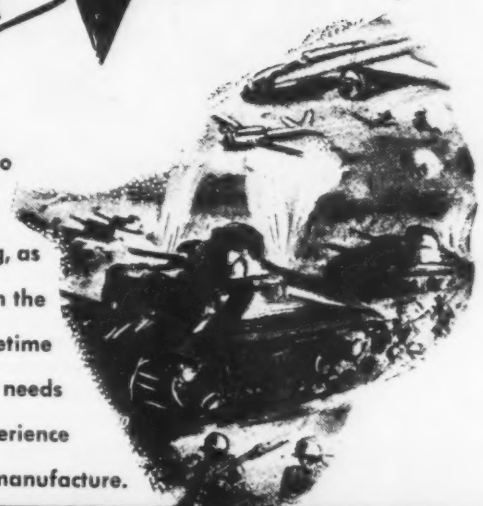

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Technical Standards. The technical standards and good engineering practices for electrical transcriptions and recordings for radio broadcasting are contained in a 4-page folder. The folder lists the fourteen pertinent facts as established by the National Association of Broadcasters and gives prices of recording discs. Obtainable from Gould-Moody Co., 395 Broadway, New York, N. Y.

Powder Metallurgy. "A Course in Powder Metallurgy" written by Dr. Walter J. Baeza will be published in February. The first section of this book outlines the history of powder metallurgy and laboratory and plant processes. The second section gives suggestions for assigning experiments to students; necessary equipment and materials (with their cost) are listed. This section will serve as a guide to industrial organizations planning a research or development laboratory. The third section outlines fifteen experiments, each of which can be performed by students in one or two four-hour laboratory periods. This book will be published by Reinhold Pub. Corp., 330 W. 42nd St., New York, N. Y.

Electrical Testing. Pamphlet T-S tells of the various technical services offered by the Electrical Testing Laboratories. E.T.L. is engaged in research, testing, analysis, inspection, surveys and statistics for industry, business, consumers and the Government. Copies of this pamphlet are available from Electrical Testing Laboratories, Inc., 2 East End Ave. at 79th St., New York, N. Y.

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Technical Manual. A revised technical manual which includes up-to-date data on all Sylvania tube types has been announced the contents of the manual are divided into different subjects: fundamental properties of vacuum tubes, including amplifier classification and definitions; general tube and circuit information; characteristics of Sylvania receiving tubes by types with listing of approximately 400 types; and typical radio receiver and amplifier circuits. Copies may be purchased from Sylvania dealers or directly from advertising department, Sylvania Electric Products, Inc., Emporium, Pa., for thirty-five cents each.

Transformers. Time tested transformers for geophysical applications are covered in bulletin TT-1-42. The frequency response, magnetic shielding, balance, tolerances, static shielding, mounting, finish, treatment and testing of transformers are outlined. Available from Thermador Electrical Mfg. Co., 5119 S. Riverside Dr., Los Angeles, Calif.

Insulators. In a twelve page booklet, the composition, processing and development of Mycalex is described. Data on the mechanical and electrical properties are given. The booklet tells in what forms it can be obtained, how it can be machined, its uses and advantages. Available from Mycalex Corporation of America, 7 E. 42nd St., New York, N. Y.

House Organ. The December issue of *The General Radio Experimenter* contains an article "Voltage Regulation of Variacs." The article, accompanied by several curves, gives a complete picture of the regulation of all the current models. This issue also lists parts and accessories which have been discontinued due to the war. An inductance chart, 17x22 inches, for single-layer solenoids is now available for framing. This chart shows the number of turns required for a given inductance in terms of the length and diameter of the winding form. Both available from General Radio Co., 30 State St., Cambridge A, Mass.

The AGASTAT, an Electro-Pneumatic Relay Making or Breaking Electrical Circuits at Predetermined Intervals.

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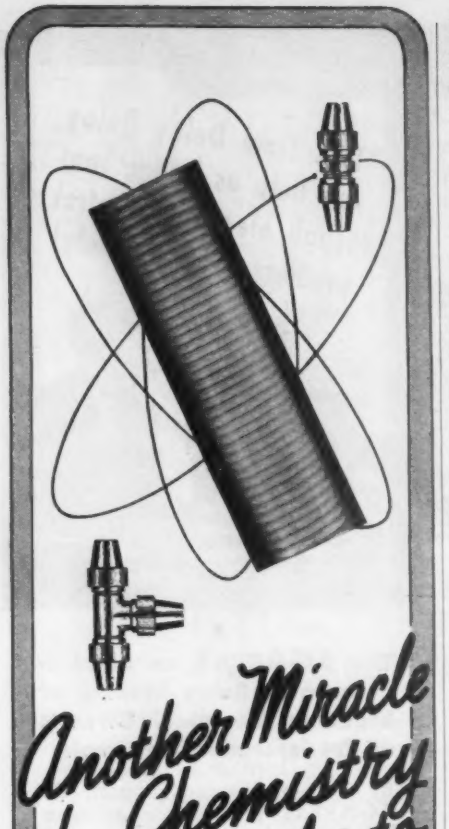

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Production of Zinc. The story of the men and equipment behind the wartime production of zinc is given in a four page folder. The manufacturing and testing of zinc metal and zinc pigment from the time it leaves the mine until it reaches the battlefront is described. New Jersey Zinc Co., 160 Front St., New York, N. Y.

Thermometers. Five new bulletins containing data on industrial indicating, recording and control thermometers are available. Complete details on characteristics, performance and limitation of each class of vapor-pressure and gas-filled instrument is given in table form. Available scales for indicating instruments and charts for recording instruments are illustrated. Bulletin G503-2 covers the recording control thermometer, Bulletin G603-2 the indicating control thermometer, Bulletin G303-2 describes and gives applications for the indicating thermometer and Bulletin G403-2 the recording thermometer. Wheelco Instruments Co., Harrison and Peoria St., Chicago, Ill.

In the November-December issue of *Wheelco Comments* thermocouple construction and design is explained. Thermocouple insulators, connector blocks, heads, protecting tubes, bushings and flanges, lead wire and lead wire connectors are described and illustrated. See the above address.

Tubes. New and revised technical descriptive bulletins and installation and operation instructions for General Electric's radio transmitting tubes data book are available. The technical descriptive bulletins available are: GET-503C, GET-762A, GET-991. Instructions available are: Index to instructions for radio transmitting tubes and GEH-125B and GEH-1066B. Available from General Electric Co., Schenectady, N. Y.

Molybdenum and Tungsten Products. Data on the various forms in which molybdenum and tungsten is available is given in this book. The characteristics, chemical behavior, and standard dimensions sheets are included for each. Other products made are described and illustrated. Included also are various conversion tables. Available from North American Philips Co., Inc., 145 Palisade St., Dobbs Ferry, N. Y.

Plastics. The new "Plastics Catalog" covers all phases of plastics and their uses. A special section "Plastics in War" gives detail application of plastics in every arm, branch and bureau of the Government having relationship with the plastics industry. This section includes a listing of Government offices maintaining procurement contacts with plastic manufacturers. Other sections deal with: (1) Materials including data on every type of plastic material being used commercially, a plastic properties chart, plasticizers properties chart and solvents properties chart. (2) Plastics Materials Manufacture, with flow sheets of basic material manufacturing processes in diagrammatical form. (3) Molding and Fabricating. (4) Finishing, Decorating and Assembly. (5) Machinery and equipment. (6) Laminates, Plywood and Vulcanized Fibre. (7) Coatings. (8) Synthetic Fibers. (9) Synthetic Rubber and Rubber-like Plastics. (10) Index and Directory. Available from Department of Public Relations, Modern Plastics Magazine, 122 E. 42nd St., New York, N. Y.

Cellulose Plastics in War and Industry is the title of a manual of specifications, properties and applications of sheets, rods, tubes, films and foils, molding materials, plasticizers, cements, dopes, and glazing materials. The manual tells of the various functions of cellulose plastics for war use. Charts and tables are included. Celanese Celluloid Corp., 180 Madison Ave., New York.

Bulletin No. 10 covers standard apparatus and utensils in transparent vitreosil. Transparent vitreosil plates, flasks, expansion apparatus, crucibles and lids, dishes, arsenic tubes, test tubes, tubing and rods, etc. are described in this bulletin. Also included is a listing of various other bulletins obtainable. The Thermal Syndicate, Ltd., 12 E. 46th St., New York, N. Y.

Electronic Products. The electrical and physical data on u-h tubes, high vacuum rectifiers, mercury vapor rectifiers, general purpose triodes, high vacuum half-wave rectifiers, and beam pentodes are given in a booklet entitled "Gamatron Electrode Products." The maximum ratings and typical operating conditions are also included. Booklet available from Heintz and Kaufman, S. San Francisco, Cal.

Electron Microscope

(Continued from page 81)

oil current. It is also possible to "immerse" the sample in the lens in order to use the short focal lengths desired in the objective. On the other hand we find that it is exceedingly difficult to permanently align any system having electromagnetic lenses. Changes in electron accelerating potential, slight changes in beam characteristics, or variations in lens current usually call for alignment adjustments. Since the electrons are accelerated by potential, while the lenses are actuated by current, any relative changes in the accelerating voltage and the lens current must be eliminated to a high degree to keep the image from blurring. Voltage and current regulation to one part in 25 to 50,000 is a customary requirement.

The type of electrostatic lens used in electron microscopy to date is of the unipotential type, the so-called "einzel-lense". It consists of three apertured discs, the center one being insulated and held at a potential difference from the outer two. Such a lens is shown in the cut-away view. The field distribution giving lens action is set by the geometry in the vicinity of the axis, i.e., the aperture diameters and the electrode spacing. The focal characteristics may be varied by varying the potential, usually negative, on the center electrode. However, one of the great advantages of this lens results from tying this center electrode to cathode potential. Then as the accelerating potential of the electrons varies with changing source voltage, the lens, in this case a potential rather than current actuated device, varies in the same ratio and the net effect is no change in focal properties of the lens. Thus very poor regulation can easily be tolerated and the accelerating potential can be changed from lowest to highest penetration value without defocusing or shifting of the image. An ordinary half-wave power supply similar to those commonly used in x-ray units is satisfactory.

Accurate machining of the lenses is necessary to insure proper lineup initially, and the surfaces of the electrodes together with the space requirements present an insulator

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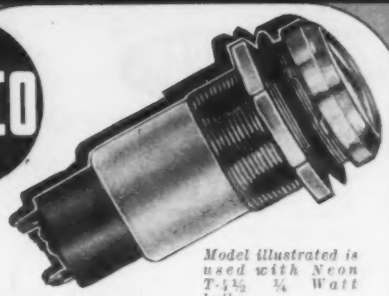

Model illustrated is used with Neon T-4½ ¼ Watt bulbs.

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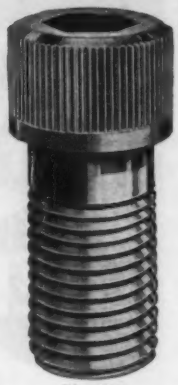

Fig. 1434

Fig. 1645
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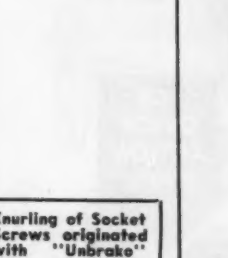

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and high voltage problem. When once assembled, the lens is a complete analogue to a glass lens in that its focal characteristics are fixed, and it may be incorporated into electron optical chains on the same basis as glass lenses in visual optics. The fixed magnification can be an advantage in that when properly calibrated it is capable of yielding accurate measurements regardless of voltage adjustments. These are the salient points in the comparison of the two types of lenses available.

General Electric Instrument Uses Electrostatic Lenses

After due consideration the electrostatic approach was chosen for the G.E. microscope. This choice made possible several innovations in the overall microscope. First of all, the power supply is simplified. An ordinary half-wave rectifier circuit using a single tube is very satisfactory. Filament brightness and accelerating potentials are controlled directly by auto transformer action in the respective transformer primaries. Ordinary line voltage fluctuations and considerable ripple can be tolerated as discussed previously. Next, since accurate initial lineup was essential, serious consideration was given to the size of the electron optical system to make accurate machining more convenient. The result was a compact "lens package" consisting of a cylinder several inches long containing three electrostatic lenses. The manipulator mechanism and a beam-limiting aperture are shown detached in the photograph. In operation this mechanism is mounted rigidly to the lens package. The gun mount and insulator assembly is shown with the filament cap removed showing the hairpin filament and mount. The end plate with the sylphon bellows also contains the fluorescent screen.

The lens cylinder and manipulator unit together constitute the parts of the electron optical system requiring accurate alignment. By removing the vacuum chamber end plate which carries the fluorescent screen, this unit can be slipped out of the vacuum chamber in a few seconds for checking or rearranging lens positions for different magnifications.

Early tests indicated that fluorescent screens could be made of such quality that viewing of the image

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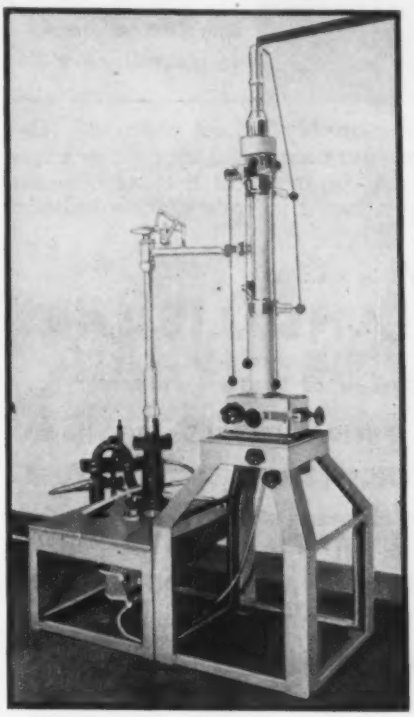
could be accomplished by transmission, and that considerable optical magnification was feasible. This removed the necessity of side viewing windows and, even more important, made possible external photography of the image. Thus the picture is taken of the fluorescent screen directly, using a conventional camera. Heretofore, internal photography had been the rule, the electrons being directed at the actual photographic plate for exposures. In addition to the simplification in camera design, external photography removes the need of the insertion chamber for the photographic plate.



Early model electrostatic model microscope made by A. E. G.

It was found that the elimination of this insertion chamber, and the reduction in volume of the main vacuum cylinder, reduced the vacuum pumping requirements to the point where, using the smallest available commercial pump, the necessary vacuum could be reached in one or two minutes after changing samples. This made possible the elimination of the preliminary insertion chamber for the sample holder. When a specimen is changed, a vacuum valve between pumps and microscope is closed and the pumps are allowed to operate while the microscope chamber is opened to air for specimen insertion. The single small rotary pump on vibration proof supports,

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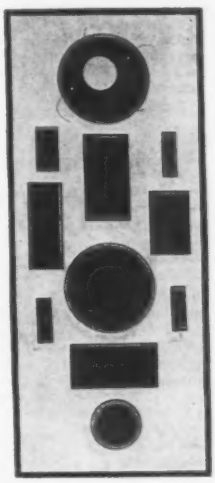

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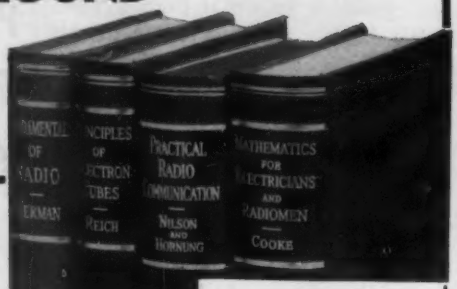

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together with an air-cooled glass oil-diffusion pump, are mounted in the base of the cabinet.

It has been customary to adjust the guns of previous electron microscopes so that a high emission spot furnishes the beam for the condenser lens. This lens can then be adjusted to concentrate the beam on the specimen as desired. The electron illuminator of the G.E. microscope eliminates the condenser lens and no adjustments of the filament or gun are necessary in operation of the instrument. When a filament mount is replaced, the gun mount having been removed from the vacuum chamber, the filament point is centered by eye using lateral adjusting screws. The mount is then replaced in its seat in the end of the vacuum chamber and proper alignment is assured.

High potential for the microscope is applied at the cable which also supplies the filament current. This cable contacts the microscope through the gun mount insulator. The gun and filament operate at high negative potential, and this same potential is carried from the gun to the center electrodes of the lenses by means of a rod running along just inside the wall of the vacuum chamber. Electrostatic shielding is necessary to prevent this rod from deflecting the electron beam off axis. Magnetic shielding is provided by a laminated cylinder of mu metal which surrounds the entire microscope cylinder and extends somewhat over the ends.

The image on the fluorescent screen can be viewed directly or it can be magnified with an eyepiece. An eight-power eyepiece having an exceptionally large flat field has proven especially useful. For taking pictures of the image, an ordinary bellows camera with a special Bausch and Lomb lens, giving about 8 diameters magnification, is used. Exposure times run from 20 seconds to two minutes. The most practical electronic magnification seems to be about 500 diameters. Coupled with the eight-power glass optic this gives a total magnification of about 4000 for ordinary work. Further enlargement can, of course, be carried out after the picture is taken.

Near the eyepiece are provided the three controls necessary for focusing and for scanning the specimen. Focusing is accomplished by mechan-

ically moving the specimen holder along the optic axis. With electromagnetic lenses, focusing is usually controlled by varying the lens current.

It can be seen that convenience in operation has been carefully watched. The overall size of the instrument is about two by three feet by four feet high. It is easily moved around on its castors and its only service requirement is about five amperes a.c. at 110 volts, which is easily obtained from any ordinary wall outlet. The microscope is completely self-contained in the cabinet, the pumps and power supply taking most of the cabinet space. The microscope proper is contained in the horizontal cylinder, the vacuum chamber being about fourteen inches long and two inches in diameter. The eyepiece is arranged horizontally at eye level with the controls close by. The only controls on the panel, four in all, are a main switch, a vacuum valve, a control for penetrating voltage and a brightness control. The vacuum system and power supplies have been so simplified that various indicating devices, pressure gauges, etc. have been eliminated. Voltages of 20 to 30 kv give a brightness on the screen comparable to that usually obtained with twice the voltage on other instruments. A working table space and drawer are provided and from a convenient sitting position samples can be prepared, inserted through the gate in the top of the mircoscope tube, and all controls manipulated without leaving the microscope. When a suitable field is encountered the viewing eyepiece is removed, a light weight camera is inserted in a special out-of-sight holder and a picture is taken of the exact image seen visually on the screen.

Some samples may be used by merely arranging to suspend the material in the path of the electron beam, the electrons thus passing through the actual sample. This technique was used in the case of the "mosquito" pictures in this article. It is likewise used in studying such things as smokes, dyes, bacteria and other materials sufficiently small or "electron-transparent". However, in many cases studies must be made of surfaces of materials impervious to electrons. One such field is that of metallography. The metallurgist has obtained much useful information concerning crystal structure by pol-

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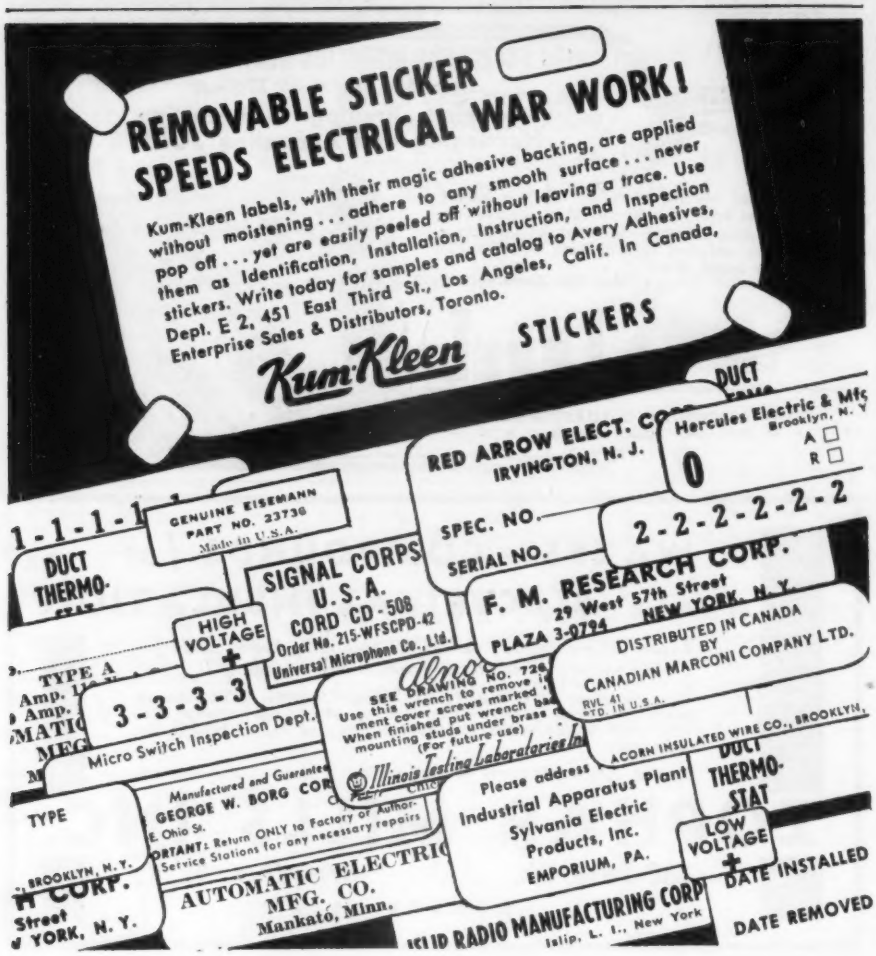

ishing and etching the surfaces of test samples which he then observes with an optical microscope. Since electrons will not pass through such a sample we go to the expedient of making a matt impression, or replica, of this etched surface using a very thin layer of some plastic material such as Formoar or collodion which can be flowed onto the surface and subsequently stripped off. High and low places on the etched surface then become thin and thick places on this replica which is mounted in the electron beam. These regions of variable thickness give to the electron beam the information they obtained from the sample by causing more or less absorption or scattering of the transmitted beam. The end result is an electron micrograph differing little from ordinary metallographic pictures except in magnification. The replica method can be used for many other samples besides metallographic specimens, of course. Replicas may be obtained from almost any surface.

• • •

Sensitive Relays

(Continued from page 73)

coil, causing a peak of flux in the small magnetic circuit of the shaded pole. This peak of flux, with resultant force on the armature, is out of phase with the main flux by nearly 90 deg. Thus the condition of zero force on the armature is avoided.

However, in the usual relay design the shading coil does not produce very much magnetomotive force. It can produce an effective amount of flux only if its working gap is very small giving maximum permeability of its magnetic circuit. This means that if the working gap of the relay, between armature and pole faces, is appreciable, the effect of the shading coil is practically nil, and buzzing is just as bad as ever. On the other hand, if an ordinary armature were allowed to seal up tight against the pole faces, there would be no assurance of closing the normally open contact circuit, as it would have to "make" at precisely the same armature position as that in which the armature struck the magnet. The solution is to use a "sprung" armature contact, which closes the normally open circuit and then yields as the armature con-

tinues toward the magnet on which it may now seal.

The difference in the adjustment of this type of relay and of those discussed above is then, that with the a-c variety, the normally open contact is advanced as far as possible without causing the armature to separate from the pole face at the minimum required input current. Drop-out value is then set with the spring as before, and pull-in by means of the normally closed contact. It is likely that there will be an unavoidable condition just before pull-in and just before drop-out when buzzing will occur.

In closing, we should like to say a word in behalf of all manufacturers of sensitive relays to all prospective users thereof. Swear us in, if necessary, but tell us all about what it is you want to accomplish with the relay! Our records show many ludicrous but sad situations that have developed when important relavant information was mistakenly withheld. A sensitive relay is not like a vacuum tube, put up in a box with its characteristics all set forth in handbooks. It is hard enough to suit it to its job even when complete information about the latter is available. The information that is lacking is always that which one thinks does not apply to the situation or which one fails to think of at all.

• • •

Waveform Unit

(*Continued from page* 66)

stationary segment. Thus the phase control adjustments control the point in the voltage cycle at which the spark passes to the stationary segment, and thus activates the mercury pool tube.

A relay circuit shown at the left of Fig. 5 is activated by the welding machine operator and contacts on the continually rotating drum. Its function is to ensure selection of one complete program as preset on the drum program discs.

Operation of a foot switch applies pressure to the welding electrodes. As soon as the required pressure has been established a pressure switch closes the circuit which initiates selection of a welding program as described above. This sequence control arrangement is of a conventional type and does not incorporate electronic circuits of any particular interest it will not be described here.

The rotary timer described above is particularly suited to the control of such power tubes as may be connected directly to the 60-cycle power source. This timer, however, may also be used to control those tubes which discharge the capacitor banks and therefore need not be synchronized with the power line. In this latter case it is often difficult to determine the point in time at which each tube should be activated. It is generally found preferable to synchronize ignition with the natural time constants of the oscillatory circuits themselves.

Figure 6 illustrates the use of self-synchronizing electronic circuits which in some modes of operation are used to control ignition of tubes 4, 5, and 6. When for instance, three condenser banks are being successively discharged, tube 3 is activated by the rotary program control immediately following the preheating period. This is done to prevent the overlap of a-c current with the condenser discharge current.

Grid control condenser C_4 is charged from capacitor bank C_1 to a voltage limited by the constant voltage drop of glow lamp *GL*. This voltage is negative with respect to the cathode of thyratron *Th*, thus maintaining the ignition circuit of tube 4 blocked. This condition tends to hold for some time after discharge of C_1 because of the relatively large values of resistors R_1 and R_2. Upon discharge of capacitor bank C_1 the voltage across its terminals is allowed to oscillate to a reverse potential of at least 100 volts. The exact magnitude of this reverse potential is controlled by the position of the slider on resistor R_1. Movement of this slider in the direction of C_4 causes a greater reverse swing of voltage across C_1 and therefore a greater delay in ignition of tube 4. Ultimate ignition of thyratron *Th* is caused by the gradually increasing reverse potential of C_1 which is applied, in part, to the grid of *Th* in positive sense.

In exactly the same way the next following discharge increment may be delayed. Similarly the shunting action of tube 6 may be delayed as desired. The effects of such delays of ignition are illustrated in oscillograms Fig. 7, supplied by Dr. W. F. Hess and his associates, to whom the authors are indebted.

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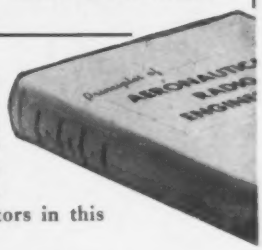

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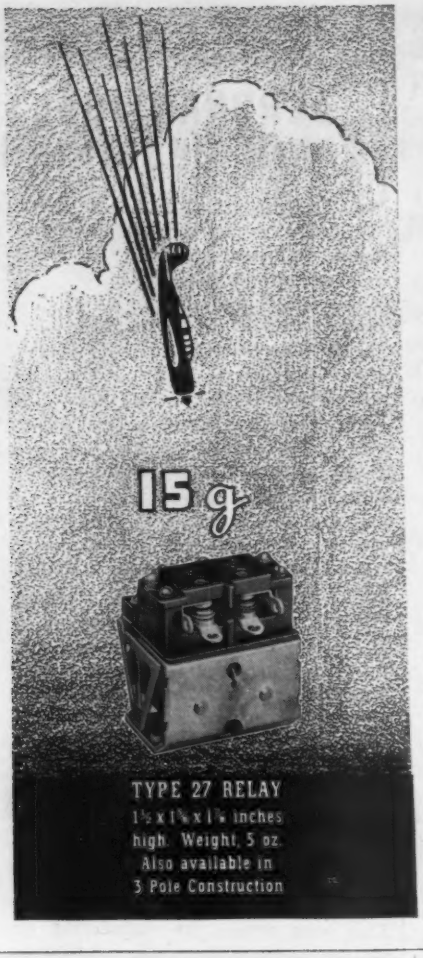

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Curve Tracer

(*Continued from page* 90)

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Incidentally, the graph can be tracked upon either of its edges, that is, the edge nearest the circumference of the chart, or the edge nearest the center of the chart, by reversing the direction of the magnetic field in which coil *A* is immersed, and also by directing the pull of the spiral tension spring in the opposite direction.

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Test Generators and Chambers

(*Continued from page 86*)

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Temperature Chambers

Component parts have commonly been subjected to temperatures corresponding to those encountered in the tropics for many years, designers using just about every conventional type of oven for this purpose and frequently using equipment initially built or bought to perform some production function. Less common has been the practice of subjecting parts to extremely low temperatures.

Since the war, chiefly because of the low temperatures encountered up in the stratosphere, specifications have become much more critical with respect to the sub-zero performance of electronic equipment. Initially this led to the purchase of many household and commercial refrigerating units for adaptation to the job at hand by laboratory and production engineers. Some biological refrigerators were pressed into service. Then a number of refrigeration equipment manufacturers designed special units to meet a need for boxes which would run the temperature down sufficiently low to shrink fabricated parts enough to facilitate certain kinds of assembly work. Inserts of one variety or another, for example, may frequently be contracted at a low temperature, then placed within other assemblies not so refrigerated and, when permitted to expand again, provide such a tight fit as to be essentially integral. Such industrial process refrigerators are obviously suitable for some elemental test purposes as well as to aid assembly and there are instances where further refinement of equipment is unnecessary.

Several sub-zero chests are built by Revco for industrial use. These have interior dimensions ranging from 22 inches wide, by 22 inches long, by 43 inches high to 35 inches wide, by 53 inches long, by 44 inches high, providing from 1.5 to 7 cu. ft. of space for production and test work. Motors range in size from $\frac{1}{3}$ to $\frac{3}{4}$ hp. Refrigeration, to minus 50 deg. F and below, is accomplished by means of specially processed compressors mounted within the units directly below storage compartments. Copper tubing is soldered to tank walls to provide rapid cooling action. Shells are made of heavy gauge cold rolled steel and tanks are made of galvanized steel. Exterior finish is baked synthetic grey enamel over bonderized steel. Insulation is of fiberglass. External joints are sealed with Permagum and internal joints are soldered air tight. Casters, permitting easy movement of both portable and heavy duty models, are of solid composition Atlasite and have ball bearing swivels. Access to work is through the box tops, tops being removable in the case of cylindrical portable models and double hinged for partial or complete opening in the case of rectangular heavy-duty models.

Low temperature industrial chilling equipment is also made by Deepfreeze, producing models providing temperatures between plus 20 and minus 20 deg. F, zero and minus 50 deg. F and between minus 60 and minus 120 deg. F, the latter unit employing cascaded refrigerating units. The chilling chamber in the cascaded unit consists of a double-wall cylinder 24 inches in diameter and 30 inches deep. The inside wall is made of 10-gauge steel and the outer wall of 14-gauge. There is 31 sq. ft of primary freezing surface and capacity is 58½ gals. or approximately $7\frac{5}{10}$ cu. ft. Two motors are used, $\frac{1}{2}$ and $\frac{3}{4}$ hp each. Two compressors employed are of the open type silent valve head, water cooled, piston type. Insulation consists of 4 inches of Santocel. Heat absorbing capacity is equivalent to $5\frac{3}{4}$ lbs of dry ice per hour at same temperature and under similar operating conditions. Body is of automobile fender steel.

Somewhat more highly specilized equipment from the standpoint of laboratory and production test uses as distinguished from assembly functions is built by American Instrument, one of this company's models maintaining temperatures up to 220 deg. F as well as down to minus 90 deg. F within plus or minus $\frac{1}{2}$ degree. Close temperature control is maintained by means of a bi-metal thermoregulator, operating through a solenoid coil and an elec-

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tronic time delay relay. Low temperatures are quickly obtained by utilizing dry ice for cooling, it being possible to drop test temperatures from, for example, plus 85 to minus 90 deg. F in 30 minutes. The cabinet consists of a plywood exterior and a rust resisting steel interior, the two being separated by 6 inches of insulation. The 24 by 24 by 24 in. working chamber has a hinged, removable cover. Another hinged, removable cover is provided for access to the dry-ice compartment. Electric heaters are automatically switched in for high temperature operation. In the fixed portion of the cover, between the hinged covers, are mounted the thermoregulator and the solenoid. Relays and switches are mounted on a control box on the end of the cabinent. The dry ice compartment has a capacity of 75 lbs and is heavily insulated from the working chamber and a bypass duct. Air is circulated through the cabinet by means of a fan located beneath the dry ice compartment and driven by a 1/30 hp induction motor equipped with permanently grease-sealed ball bearings, the motor being mounted outside the cabinet. The dry-ice compartment is provided with an externally controlled hand damper, which limits the amount of air passed over the dry ice according to the temperature desired. A scale permits quick setting of the damper. To minimize condensation and frosting, all parts extending from inside to outside are made of materials having a low coefficient of heat transmission.

A new chamber has been designed by American Coils specifically for test purposes. It is completely automatic in operation, employs mechanical refrigeration, features quick pull-down and has a range from minus 67 to plus 160 deg. F. A two-stage refrigeration unit is used, with positive air circulation and controls insuring uniform temperature. Usable interior is 59 in. wide, by 28½ in. high by 30 in. deep. Door opening is 51½ in. wide by 26½ in. high, the door containing a five-glass viewing window 46 in. wide by 21½ in. high. The cabinet is of all-steel construction, embodying an inner liner of 16-gauge metal with welded seams and an outer casing of 20-gauge metal locked and soldered to prevent passage of vapor to insulation. Insulation is 6 inches of fiberglass. Wood frames act as a load support and breaker strip. The interior is divided by a partition to form a coil compartment above the usable interior. The door is of step design, three steps having sponge rubber gaskets. Glasses are sealed and dehydrated against future passage of moisture. Compressor equipment consists of a two-stage, water-cooled Freon condensing unit driven by a 7½-hp, 3-phase, 220- or 440-v motor. Other equipment includes two 110-v motors for cooling fans, a 6000-watt heating assembly mounted in a special duct, a 110-v motor operating a heating fan, three 12 in. Lumiline lamps, two 110-v outlet boxes, temperature controls and relays, safety pilots for cooling and heating circuits, solenoid valves, liquid line shutoffs, heat exchanger, dehydrator, sight glass, sub coolers, expansion valves and all necessary tubing and fittings.

Temperature, Pressure and Humidity

Certain specifications require testing of electronic equipment not only at temperature extremes but also at atmospheric pressures varying between those encountered below sea-level and the stratosphere as well as at humidities comparable to conditions encountered all the way from desert dryness to sub-tropical saturation. In many instances the speed with which test conditions can be varied, particularly with reference to temperature, is an important consideration. Highly specialized test chambers which meet all of these requirements have, therefore, been developed by several firms and others of similar nature will undoubtedly be announced in the months immediately ahead.

Two typical test chambers made by Mobile Refrigeration provide temperature test ranges between plus 158 deg. F and minus 40, 76 or 100 deg. F, thermostatically held within plus or minus two degrees. Test spaces are 24 in. high, by 24 in. wide, by 16 in. deep and 12 in. high by 12 in. wide by 12 in. deep. Altitude equivalents up to 80,000 ft are obtainable, as are internal pressures to 30 lbs per sq in. Test conditions may be varied with sufficient rapidity to simulate a 10,000 ft. per minute rate of climb. Humidity, variable over a wide range, may be manually or automatically controlled.

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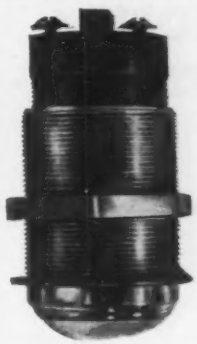
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NEW ADVERTISEMENTS received by 10 A. M. February 10th will appear in the March issue, subject to limitation of space available.

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y Kold-Hold operates between plus 00 and minus 75 deg. F, with nternal pressure variations from mbient at the location of the unit o 3 inches of mercury absolute. oth temperature and pressure vari- tions are controllable throughout eir ranges. Interior chamber olume is 186 cu. ft. Freon 12 is used s a refrigerant. Refrigeration ef- ect, or heat acceptance from the hamber, is by forced convection hrough coils designed for extremely ow temperature work. Each coil ill accept a minimum of 200 BTU er degree at minus 75 deg. F and inches mercury pressure. Humid- y control is from 25 to 95 percent, elative to all temperatures above lus 40 deg. F, or at a fixed bottom emperature of plus 32 deg. F. Be- ow this level absolute humidity will orrespond to the air saturation at he coil temperature, which will av- rage 15 to 20 deg. lower than the hamber temperature. Heating equip- ent for higher temperatures is omposed of strip heaters so ar- anged that forced convection cir- ulates air during the heat cycle. hree indicating recorders are pro- ided for continuous recording of emperature, pressure and humidity. welve mechanical connector shafts hrough the outer shell of the cham- er project inside the liner, permit- ing the attachment of either a flex- ible shaft, an angular rigid shaft or small belt-drive to any mechanical art that may be mounted in test osition within the chamber. Eight- en electrical connections are pro- ided. A separate machine compart- ent is located back of the unit, but ay be placed adjacent to the end. his same company is designing and ill shortly make available a new est chamber especially intended for ork with quartz crystals.

Tenney Engineering, making a ide variety of temperature and umidity test apparatus, has one articular high altitude chamber mbodying extreme flexibility. Tem- erature range in a standard model s from plus 150 to minus 40 deg. F. efrigerating effect is obtained ither by the evaporation of Freon n blast coils or by the circulation f an organic solvent, pre-cooled by ry ice, depending upon the nature f desired service. For temperatures elow minus 40 deg. F cascaded con- ensing units are used. Heating is ccomplished by electric air heaters mounted in a vigorously recirculated air stream. Desired humidity is produced by spraying a small amount of water into the air stream, from which the entrained droplets are removed in an efficient eliminator. Rate of pressure change is governed by the size of the vacuum pump integrally mounted on the unit. The pump runs continuously during the chamber's operation and pressure is indicated on a 6-inch vacuum gauge, calibrated in feet of altitude. Rate of evacuation can be altered to meet specific requirements, standard equipment requiring 1 minute to reach the equivalent of 10,000 ft altitude and 7½ minutes to reach the equivalent of 50,000 ft. For visibility, an 18 by 20 in. tempered plate glass window is built into the door. This observation port is insulated by multiple plate glass sections, sealed to prevent interior condensation. For electrical connections to apparatus under test, two types of lead-ins are provided. A low-voltage, low-amperage connector panel is made up of 26 conductor rods spaced on 1½-in. centers. These rods are terminated inside and out with Bakelite knobs and installed in such a manner that the terminals are at all times kept above the ambient dewpoint. This prevents sweating on the inside when the chamber is being operated at high temperature and humidity and keeps the outer terminals dry when the unit is run at very low temperatures. If a high-voltage and high-frequency circuit is required standard antenna lead-ins are furnished. To facilitate the introduction of miscellaneous connections, such as air or water pipes and thermocouple wires, Bakelite tubes are mounted in the walls. These tubes or sleeves are kept to standard pipe sizes. To make mechanical adjustment of apparatus under test, small rotating shafts are installed when required. These may be manually turned from the outside of the chamber, studs extending through suitable packing to keep them air-tight. When rotary power must be introduced, a small, stainless steel shaft is furnished. This shaft is mounted internally and externally on ball bearings and passes through a packless vacuum seal. Included in the chamber design is a two-pen recording controller, one pen for dry-bulb temperature and the second for wet-bulb temperature.

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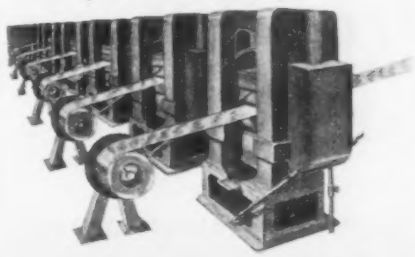

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NEW BOOKS

Engineering Mechanics

By Frank L. Brown, *Professor of Applied Mechanics, University of Kansas. John Wiley and Sons, New York. Second edition. 503 pages. Price, $4.00.*

This volume is designed as a general textbook for engineering students and covers statics as well as kinematics and kinetics for undergraduates. The text adheres closely to an elucidation of principles, and the author has eliminated many applications often found in texts on mechanics, although a few of the more important applications have been retained.

The first part of the book is devoted to a study of statics in which co-planar and non-co-planar forces in equilibrium are discussed. The topics such as friction, suspended cables and centers of gravity, requiring an understanding of calculus, are reserved for the last portion of the first section.

The second part of the volume discusses not only kinetics, which might be expected in a book on mechanics, but kinematics which is often treated as a separate subject. It would seem that the student using this volume would benefit from the unified treatment of kinetics and kinematics, particularly since chapters on kinetics and kinematics appear alternatively whether the motion is that of translation, rotation or of plane motion. The final chapters deal with work, power, energy, work and energy, linear impulse and linear momentum, and angular impulse and angular momentum.

More than twelve hundred problems are provided, most of which the answers are given.—B.D.

• • •

Experimental Electronics

By Ralph H. Muller, R. L. Garman, *and* M. E. Droz, *all of New York University. Prentice-Hall, Inc. 1942. 330 pages. Price $4.65 ($3.50 to colleges.)*

This interesting book has been written by three professors of chemistry, and while it might seem unusual for chemists to write a book on electronics, it is a fact that many of the books being presented today on various aspects of electronics are written by men who know too much of their subject to make the books as useful as texts as one would like. This book of experiments is well done, and should prove useful as a laboratory book. In addition it contains sufficient explanatory material to enable its user to gather quite a comprehensive knowledge of practical electronics, especially of non-communication electron-tube applications.

The text is a result of teaching the practical uses of electron tubes to aca-

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330 West 42nd St. New York, N. Y.

Index to Advertisers

	Page
Abbott Instrument, Inc.	144
Acheson Colloids Corporation	170
Aerovox Corp.	165
Allied Control Co.	120
Allied Radio Corp.	170
American Gas Accumulator Company	193
American Lava Corp.	26, 27
American Radio Hardware Co., Inc.	135
American Screw Co.	44, 113
Amperex Electronic Products	Inside Front Cover
Amperite Co.	168
Arnold Engineering Co.	184
Astatic Corp.	150
Audak Co.	210
Automatic Electric Co.	188
Avery Adhesives	200
Barker and Williamson	134
Bendix Aviation Corp.	50
Birtcher Corp., The	205
Bliley Electric Co.	108
Brach Mfg. Corp., L. S.	191
Bradley Laboratories, Inc.	197
Brand & Co., William	47
Bristol Co.	113
Bud Radio, Inc.	164
Burndy Engineering Co.	29
Callite Tungsten Corp.	102
Cannon Electric Developement Co.	118
Capitol Radio Engineering Institute.	197
Cardwell Mfg. Corp., Allen D.	124
Carter Motor Co.	150
Celanese Celluloid Corp.	12
Centralab Div., Globe Union, Inc.	21
Central Screw Co.	113
Chandler Products Corp.	113
Chicago Transformer Corp.	173
Cinaudagraph Corp.	138
Cinch Manufacturing Corp.	99
Clare & Co., C. P.	34
Clarostat Mfg. Co., Inc.	203
Cohn, Sigmund	192
Continental-Diamond Fibre Co., Inc.	141
Continental Screw Co.	113
Corbin Screw Co.	113
Cornell-Dubilier Electric Corp.	7
Corning Glass Works, Insulation Div.	10, 11
Cramer Company, Inc., R. W.	189
Cross, H.	205
Crystal Products Company	15
Dalis, Inc., H. L.	174
Daven Co.	Inside Back Cover
De Jur-Amsco Corp.	40
Deutschman Corp., Tobe	6
Dial Light Co. of America, Inc.	195
Dixon's Typhonite ELDORADO Pencils	207
Dolph Co., John C.	158
Drake Manufacturing Co.	204
Driver Co., Wilbur B.	207
Driver-Harris Company	208
DuMont Labs., Allen B.	128
Dunn, Inc., Struthers	19
Eicor, Inc.	200
Eisler Engineering Co.	205
Eitel-McCullough, Inc.	52
Elastic Stop Nut Corp.	110
Electro-Voice Mfg. Co., Inc.	109
Erie Resistor Corp.	38
Fada of New York	205
Federal Tel. & Radio Corp.	36
Felker Mfg. Co.	123
Ferranti Electric, Inc.	163
Foote Mineral Company	22
Formica Insulation Co.	48
Freeland & Olschner, Inc.	181
Garner Co., Fred E.	193
General Ceramics & Steatite Corp.	33
General Electric Co.	9, 39, 96, 97
General Industries Co.	191
General Instrument Corp.	35
General Radio Co.	130
G-M Laboratories, Inc.	202
Goat Metal Stampings, Inc.	185
Gothard Mfg. Co.	192
Gould-Moody Co.	137
Guardian Electric Mfg. Co.	155
Hallicrafters Co.	8
Hammarlund Mfg. Co., Inc.	14
Hardwick-Hindle, Inc.	46
Harrison Radio Corp.	205
Harvey Machine Co., Inc.	129
Harvey Radio Co.	193
Harvey Radio Lab's., Inc.	199, 205
Harvey-Wells Communications, Inc.	179
Hatry & Young	195
Heintz & Kaufman, Ltd.	37
Hewlett-Packard Co.	151
Hipower Crystal Co.	205
Hodgman Rubber Co.	194
Holliston Mills, Inc.	147
Hudson Wire Co.	178
Hunter Pressed Steel Co.	41
Hytron Corp.	115
Industrial Condenser Corp.	167
Instrument Resistors Co.	154
International Resistance Co.	101
International Screw Co.	113
International Tel. & Tel. Corp.	36
Irvington Varnish & Insulator Co.	119
Isolantite, Inc.	43
Jackson Electrical Instrument Co.	111
Jefferson Electric Co.	106
Jefferson-Travis Radio Mfg. Co.	117
Jelliff Mfg. Corp., C. O.	208
Jensen Radio Mfg. Co.	143
Jones, Howard B.	182
Kahle Engineering Co.	205
Kenyon Transformer Corp.	168
Kester Solder Company	116
Keuffel & Esser Co.	3
Kirkland, H. R.	205
Kold-Hold Mfg. Co.	166
Lafayette Radio Corp	187
Lampkin Laboratories	205
Lamson & Sessions Co.	113
Lapp Insulator Co.	51
Lepel High Frequency Lab's., Inc.	199
Lewyt Corporation	177
Linde Air Products Co.	170
Lingo & Son, Inc., John E.	182
Lord Manufacturing Co.	139
Macallen Company, The	104
Mallory & Co., Inc., P. R.	54
McGraw-Hill Book Co., Inc.	142, 198, 201, 202
Meissner Mfg. Co.	185
Metroloy Company	176
Millen Mfg. Co., Inc., James	148
Mitchell-Rand Insulation Co., Inc.	31
Mobile Refrigeration, Inc.	169
Murdock Co., Wm. J.	136
National Company, Inc.	182
National Electrical Mfrs. Association	23
National Screw & Mfg. Co.	113
National Union Radio Corp.	188
New England Screw Co.	113
New York Transformer Co.	28
Ohmite Mfg. Co.	127
O'Neil-Irwin Mfg. Co.	156
Parker Co., Charles	113
Parker-Kalon Corp.	24, 113
Par-Metal Products Corp	184
Pawtucket Screw Co.	113
Perkin-Elmer Corporation	186
Permo-Products Corporation	187
Pheoll Mfg. Co.	113
Phillips Screw Manufacturers	113
Pioneer Gen-E-Motor Corp.	164
Potter & Brumfield	160
Radio City Products Co.	171
Rauland Corp., The	13
Raytheon Mfg. Co.	45, 156
RCA Mfg. Co., Inc.	20, 107, Back Cover
Remler Co., Ltd.	160
Rex Rheostat Co.	205
Rogan Brothers	196
Russell, Burdsall & Ward Bolt & Nut Co.	113
Scovill Mfg. Co.	113
Shakeproof Lock Washer Co.	113
Shallcross Mfg. Co.	140
Shure Brothers	105
Sigma Instruments, Inc.	190
Signal Indicator Corp	205
Simpson Electric Co	161
Sola Electric Co.	121
Soundscriber Corporation	178
Southington Hardware Mfg. Co	113
Speedway Manufacturing Co.	202
Speer Carbon Co.	145
Sprague Specialties Co.	42, 133
Stackpole Carbon Co.	125
Staedtler, Inc., J. S.	185
Standard Pressed Steel Co.	196
Standard Transformer Corp.	103
Sylvania Electric Products, Inc.	16
Synthane Corp.	17, 18
Taylor Fibre Co.	195
Tenney Engineering, Inc.	159
Terminal Radio Corp.	205
Thermador Electrical Mfg. Co.	122
Thomas & Skinner Steel Products Co.	210
Thordarson Electric Mfg. Co	112
Triplett Electrical Instrument Co.	32
Tung-Sol Lamp Works, Inc.	49
Turner Co., The	132
Union Carbide & Carbon Corp.	170
United Cinephone Corporation	204
United Electronics Co.	25
United States Testing Co.	153
United Transformer Co.	2
Universal Microphone Co., Ltd.	162
University Laboratories	205
Utah Radio Products Company	114
Walker Turner Co., Inc.	149
Ward Leonard Electric Co.	157
Ward Products Corp.	146
Western Electric Co	131
Westinghouse Elec. & Mfg. Co.	4, 5
Weston Electrical Instrument Corp.	30
White Dental Mfg. Co., S. S.	183
Whitney Screw Corp.	113
Wilson Co., H. A.	183
Wincharger Corp.	175
Zophar Mills, Inc.	199
PROFESSIONAL SERVICES	208
SEARCHLIGHT SECTION (Classified Advertising)	
EMPLOYMENT	206
USED EQUIPMENT FOR SALE American Electric Sales Co., Inc.	206

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biology and engineering. While there is a modicum of material pertaining to communication circuits, the avowed emphasis is on such matters as apply more particularly to industrial uses of tubes. Thus the major chapter headings are Triodes, Photo-electric cells, Power supplies, Multigrid tubes, Gaseous tubes, Vacuum-tube voltmeters, Oscillators, Cathode-Ray tubes, and Untuned (a-f) amplifiers.

The type of contents may be learned from a look at the item heads: relays, relay contacts, coil specifications, time constants, feedback, time delays, barrier-layer cells, photometers, multiplier tubes, iconoscopes, trigger circuits, light beam control uses, etc. There are approximately 70 experiments, each of which seems to be adequately described. The remainder of the book is taken up with straight text material selected by the authors from such periodicals as *Proceedings of the I.R.E.*, *Review of Scientific Instruments*, ELECTRONICS (many references), *Industrial Engineering Chemistry*, *Wireless Engineering* and other places where electronic circuits may be found described. Each chapter has a list of additional references, both to books and to periodicals.—K.H.

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Plastics for Industrial Use

BY JOHN SASSO, *McGraw-Hill Book Company, New York, 229 pages. Price $2.50.*

THE PROGRESS BEING made in many industries at the present time is so rapid that considerable effort is expended with the main objective of not falling too far behind the times. "Plastics for Industrial Use" enables the non-specialist to obtain a clear insight into the characteristics, uses and processing techniques encountered in the plastic industry while at the same time serving as an engineering handbook of materials and methods for those actively engaged in the design and production of plastic devices.

The effect of war and priorities has been to intensify the trend toward the use of plastic material as replacement or substitutes for previously used material. But plastic materials can be used to their best advantage only if their characteristics and production requirements are thoroughly understood. Mr. Sasso has attempted to meet these needs on the part of design engineers in the present volume.

The first two chapters deal with the available types of basic compounding materials, and the comparative properties of plastic materials from the electrical, thermal, and mechanical points of view. The following six chapters deal broadly with the principles of molding and finishing molded plastics. Considerable emphasis is placed on some common faults in molding, and of correcting them. The remaining ten chapters deal in greater detail with various types of plastics, classified largely according to their chemical composition.

A directory of trade names, suppliers and molders, together with an index, complete the volume.

The extensive use which plastics are playing in the electronics field should make this volume a worth-while engineering handbook and reference work for designers and construction men who may be required to use or process plastics.—B.D.

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Radio Today

By ARNO HUTH, *Geneva Research Center, 1942. 160 pages. Price, 40 cents.*

THE GENEVA RESEARCH CENTER is an independent private organization devoted to the advancement of the study of international relations. The author of this booklet is well known in the international radio world, and his publications in both French and English are large in numbers and scope.

The present study is a survey of broadcasting today. It outlines the several means by which broadcasting in the many countries is controlled, administered and financed; it gives in detail the situation in many countries with regard to taxes applied to radio, the number of stations, the political problems, numbers of listeners, etc. Finally, Dr. Huth discusses the new aspects of broadcasting, such as FM, television and facsimile.

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